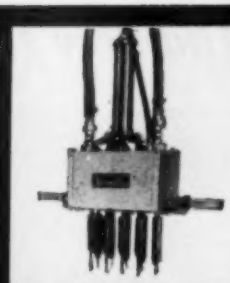
AUTOMOBILE ENGINEER

DESIGN · PRODUCTION · MATERIALS

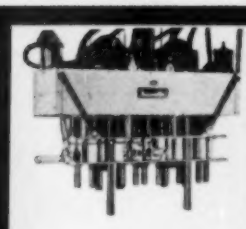
Vol. 51 No. 6 JUNE 1961 PRICE: 3s. 6d

CHOUF!



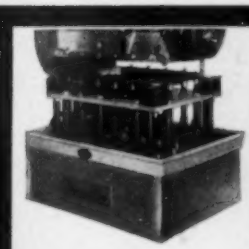
A Desoutter multi-studrunner plants 9 studs into an Austin cylinder block.

CHOUF!



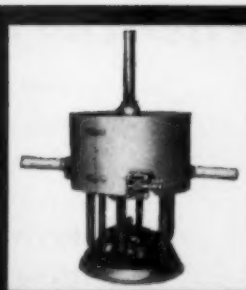
A Desoutter multi-nutrunner fixes 25 nuts on a Ford diesel cylinder head.

CHOUF!



A Triumph Herald sump is put on by a Desoutter 16-spindle multi-nutrunner.

CHOUF!



A Desoutter multi-nutrunner assembles a Vauxhall clutch plate, or tightens the wheel nuts on a Rootes Group car. And so it goes on. Nearly all mass-producing industries have a taste for that sort of music—and something to play it on! CHOUF! (on a carburettor)... CHOUF! (or a light fitting)... CHOUF! (or a washing machine)... CHOUF! (or anything else that needs assembling)

DESOUTTER MULTI NUTRUNNERS · SCREWDRIVERS AND STUDRUNNERS

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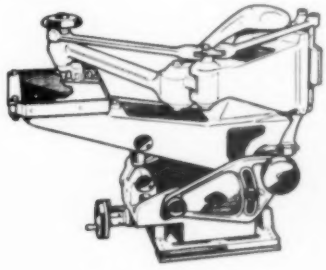

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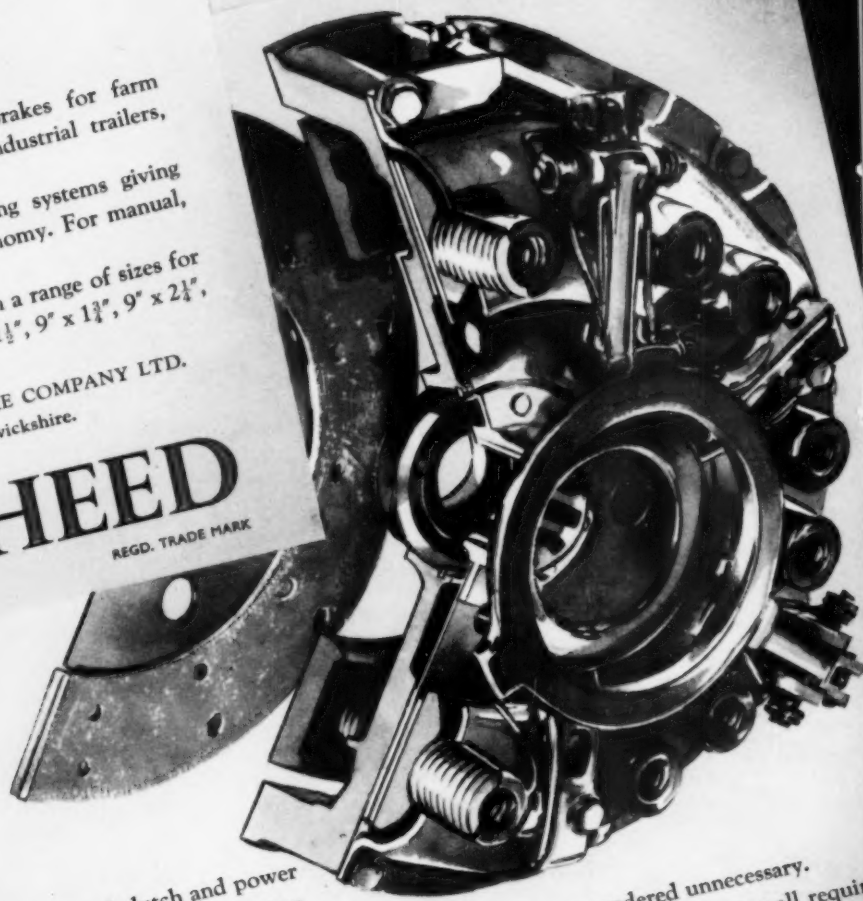

The integral clutch and power take-off for tractors comprises two clutches mounted in tandem; in most cases a separate engine for driving implements is rendered unnecessary. In addition there is an extensive range of Borg & Beck clutches covering all requir also a wide range of Rockford over-centre clutches and power take-offs. May our representative call and discuss your problems?

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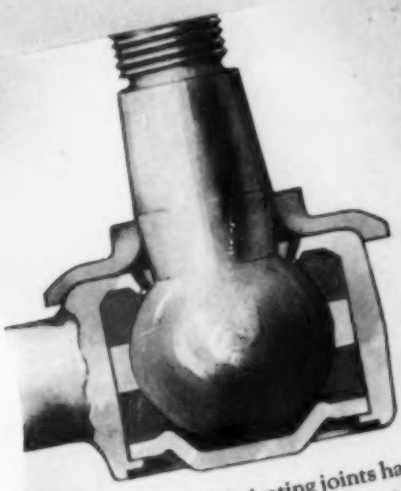
THE AUTOMOTIVE PRODUCTS GROUP



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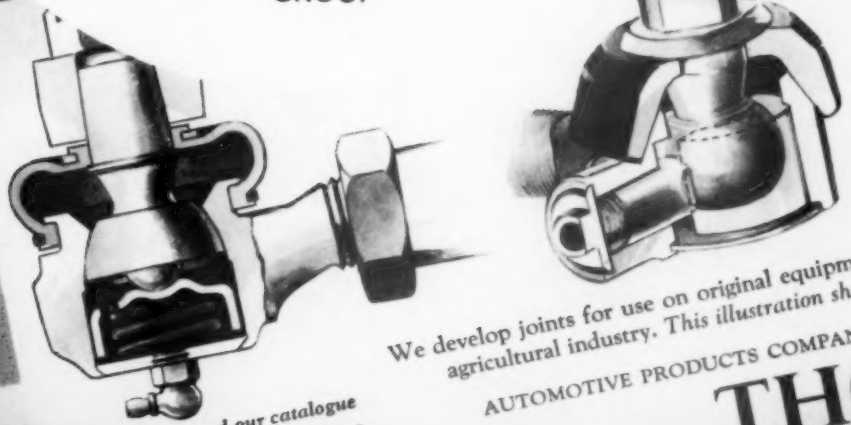

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μ has many meanings. One of the most mysterious things it symbolises is friction. No-one knows exactly what friction is; but you know some of the problems and possibilities it presents.

Ferodo is well equipped to find answers to the problems, and ways of exploiting the possibilities.

Think of our background: it includes every aspect of friction and friction materials for brakes and clutches. We manufacture every established type of friction material, from the most conventional to sintered metals and cermets.

Better still, we devote an unusually large proportion of effort, equipment and money to our research laboratories—incomparably the finest of their kind in the world.

And all these production and research resources can be put to work for you.

FOR EXAMPLE . . .

Automatic Transmissions commonly depend on a multiplicity of drive and control systems, each with its own special friction problems demanding materials with individual characteristics. So far, these demands have been met by Ferodo materials of one sort or another. But perhaps you have a special problem?

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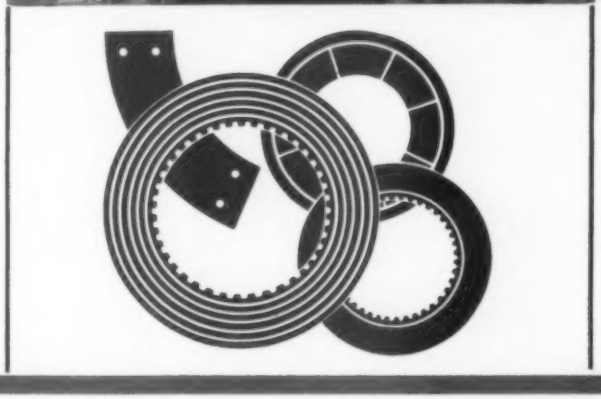

Friction Materials themselves may suggest simplified answers to apparently complicated questions. We believe that many brake, clutch and transmission problems could be solved more quickly by designing round the friction materials available. Would you like to consult us at the design stage?

Remember—only Ferodo manufacture a complete range of friction materials: and therefore only Ferodo can promise completely unbiased advice on friction problems. You are cordially invited to bring us such problems.

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From the full range of Saffire equipment there's sure to be a Saffire which can help cut your production costs; ask any of our 38 branch offices for experienced and expert advice.
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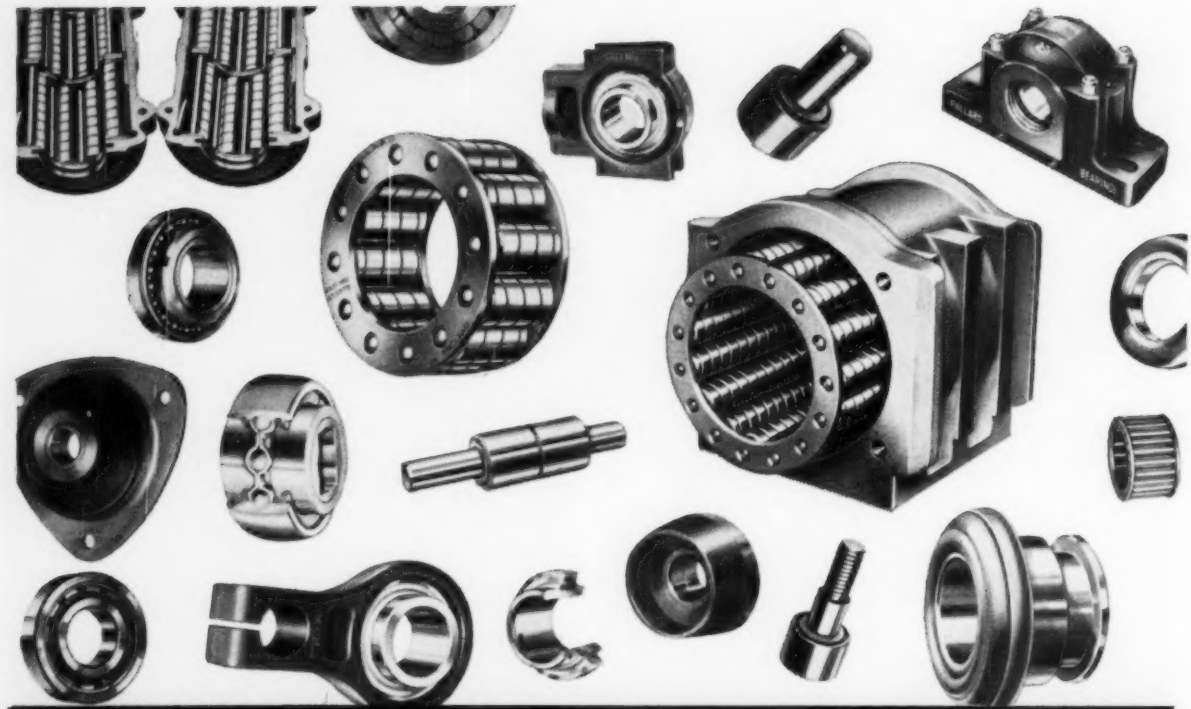

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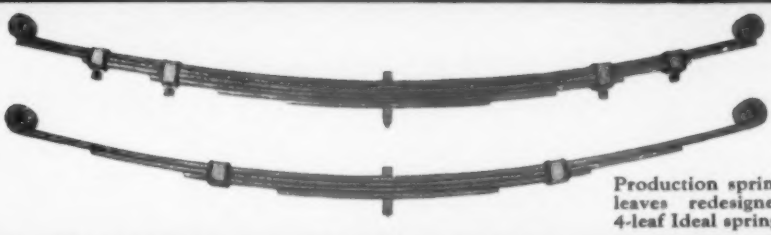
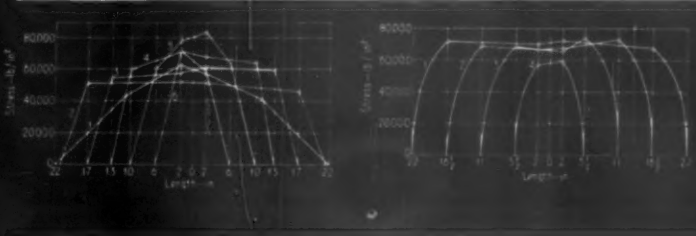
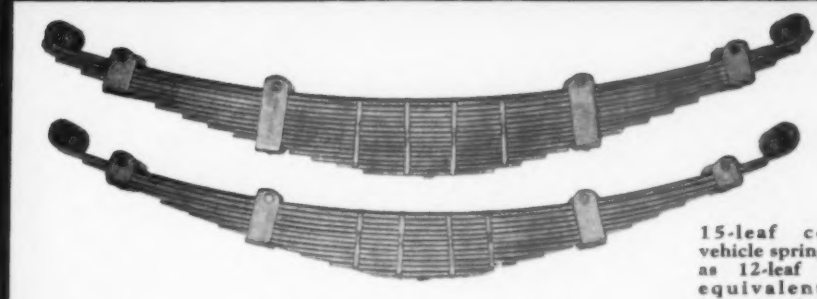
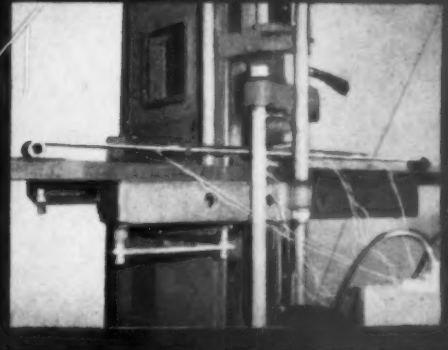


Production spring with 6 leaves redesigned as a 4-leaf Ideal spring.





15-leaf commercial vehicle spring redesigned as 12-leaf Featherlight equivalent without increase in maximum stress.



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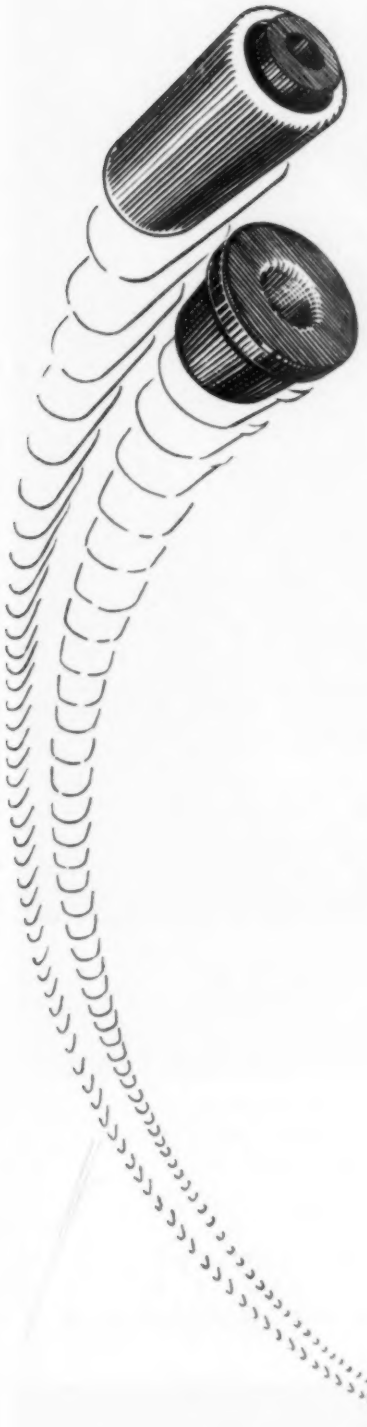

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Harrisflex controlled flexible bearings are being used for an ever increasing range of applications with new motor vehicles where either space or weight restrictions are involved. In addition these units offer advantages in their ease of assembly on production lines.

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by

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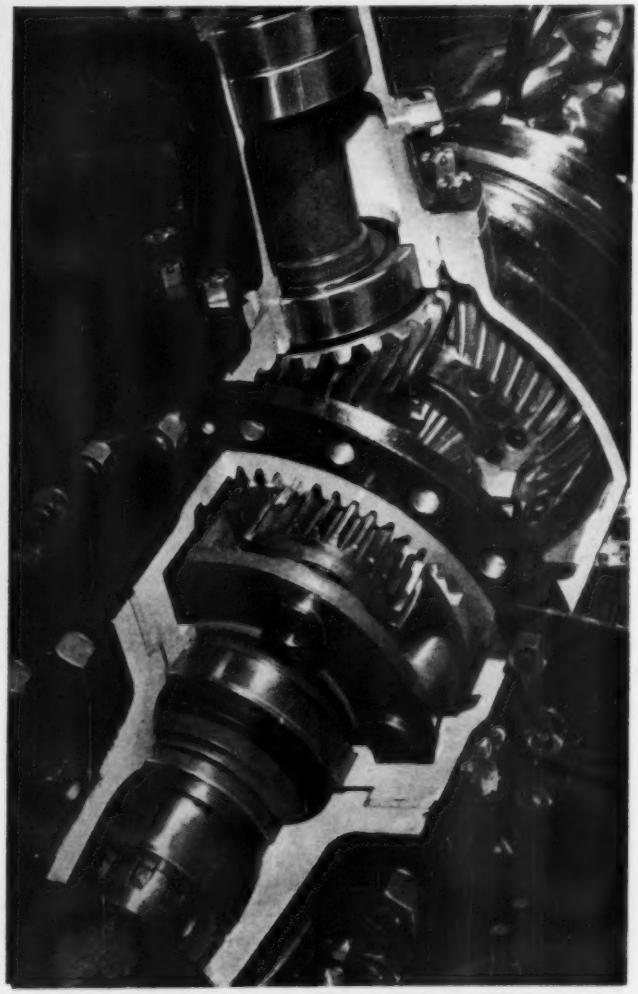
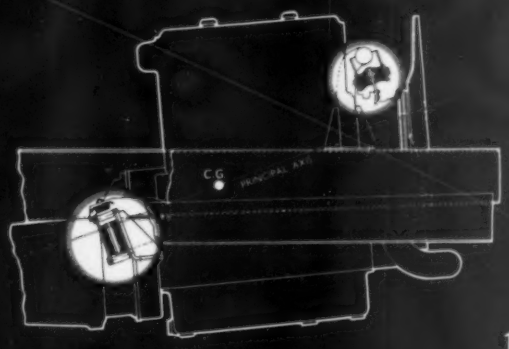


Heavy duty axle. Scammell Lorries Ltd

THE FIRTH-DERIHON STAMPINGS LIMITED, SHEFFIELD

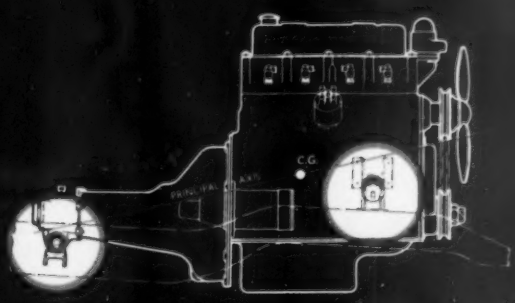
ENGINE SUSPENSION



1

If practical considerations could be ignored there would be no problem in providing the ideal suspension for every motor vehicle engine. Mountings would be disposed symmetrically about all three principal axes of inertia and fitted on the longitudinal axis on the lines of "Floating Power" — the suspension technique developed by Metalastik in this country Such an arrangement is not often convenient and the most successful engine suspension is generally a compromise, simulating as closely as possible the characteristics of the ideal but respecting the claims of easy installation and other technical and economic factors so often at variance with theoretical perfection.

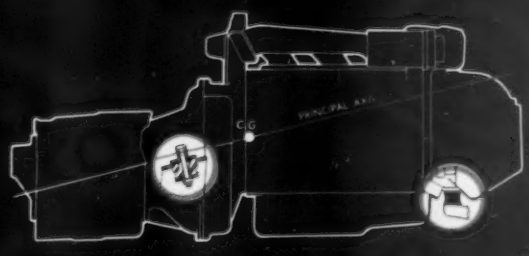
Examples of Metalastik suspension in Figs. 1, 2 and 3 illustrate how a combination of sound theory, appreciation of the practical and choice from an unequalled range of mounting units, bring maximum smoothness to different types of engine.



2

The suspension in Fig. 1 with the high front mounting resembles more closely the original "Floating Power" conception than is now usual. Secondary out-of-balance forces and a flexible chassis necessitate mountings with a large degree of vertical and rotational flexibility, hence the use of shear mountings at all three points. Pre-compression of the rear mountings permits higher stressing without loss of fatigue life.

Fig. 2 shows a typical suspension for a 4-cylinder motor car engine. Interleaved sandwich mountings are below the principal axis but 'focused' in 'V' formation to give the same rotational characteristics as mountings fitted higher but with their compression axes in a vertical plane. The Metaxentric bush at the rear controls fore-and-aft movement and has a higher deflection than a concentric type.



3

For the 3-cylinder opposed piston engine (Fig. 3) in which balancing has virtually eliminated the primary, vertical out-of-balance couple, slotted Metacones and the way in which they are fitted, provide high rotational flexibility about the vertical axis essential for insulation of vibration due to a horizontal out-of-balance couple.

Diagrams reproduced by courtesy of the Institution of Mechanical Engineers from the paper "The Suspension of Internal Combustion Engines in Vehicles", by M. Horovitz, B.Sc., (Eng.), A.M.I.Mech.E.

METALASTIK

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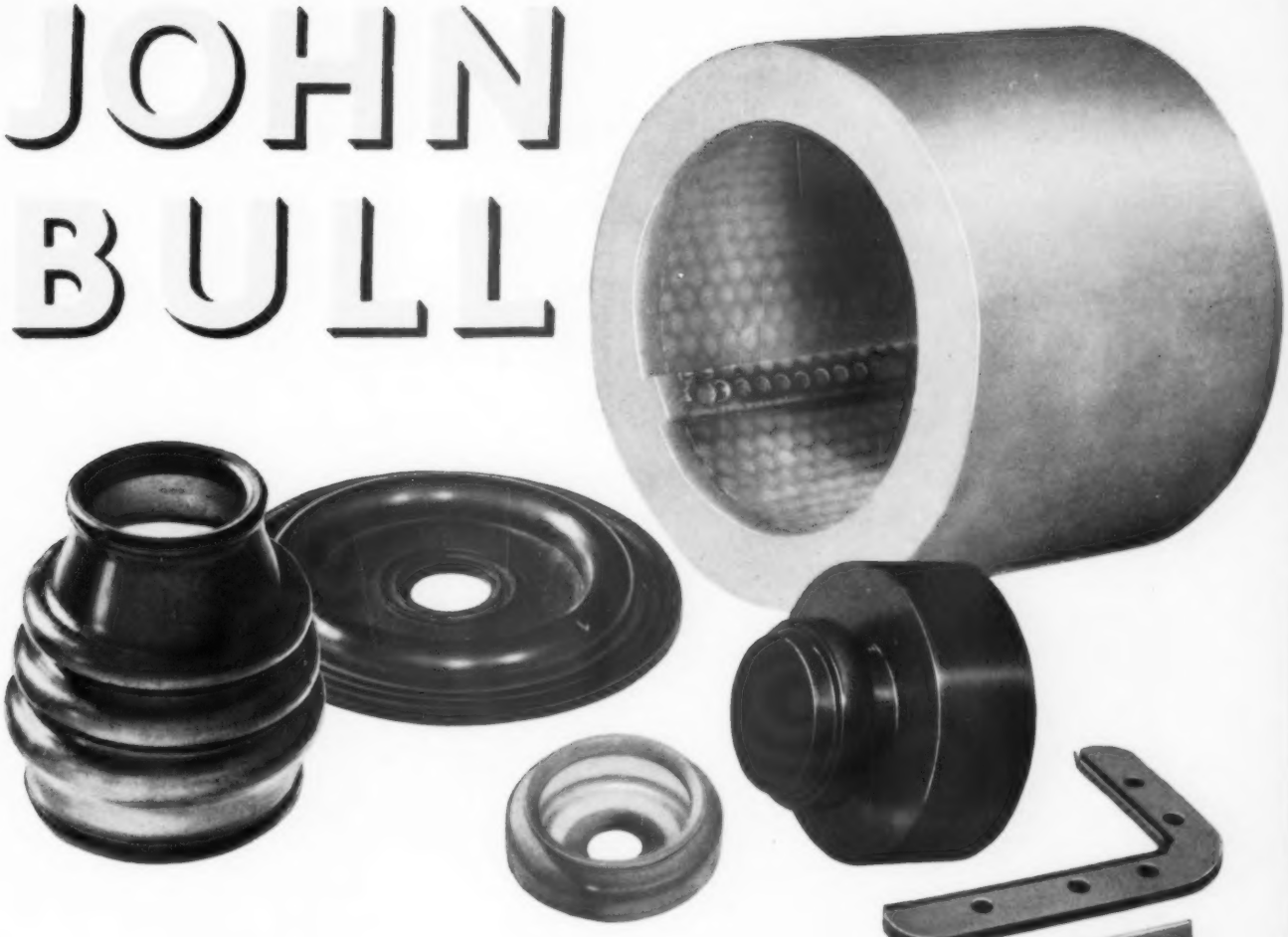

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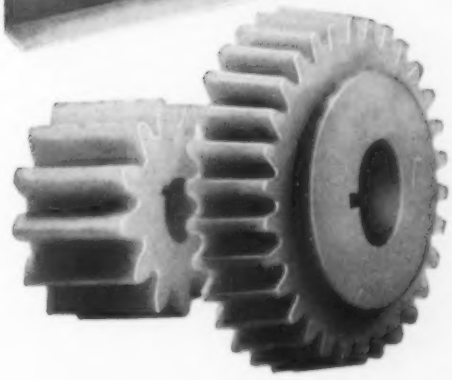
High tensile strength, resistance to impact, a remarkable capacity to withstand abrasion and tearing are the outstanding characteristics of Prescollan—the polyurethane rubber manufactured by John Bull for exacting and heavy-duty applications. The resistance of Prescollan to tearing and abrasion is five times better than that of the best natural rubber tyre tread stock.

Prescollan resists many oils and fuels, weathering and ozone attack and may be used in temperatures up to 100°C. Due to the very high modulus of the harder grades, it combines the advantages of rubbers and plastics.

Specialised grades of Prescollan have been developed by John Bull. Our technical staff will be glad to advise on the selection of the most suitable grade for your application and to assist with the design of components so that full advantage may be gained from Prescollan's unique properties.



Prescollan components illustrated are Bellows, Diaphragm, Steering Joint Cover, Roller Section for rice mill, Buffer, Machine Tool Slideway Wipers and Silent Gears.

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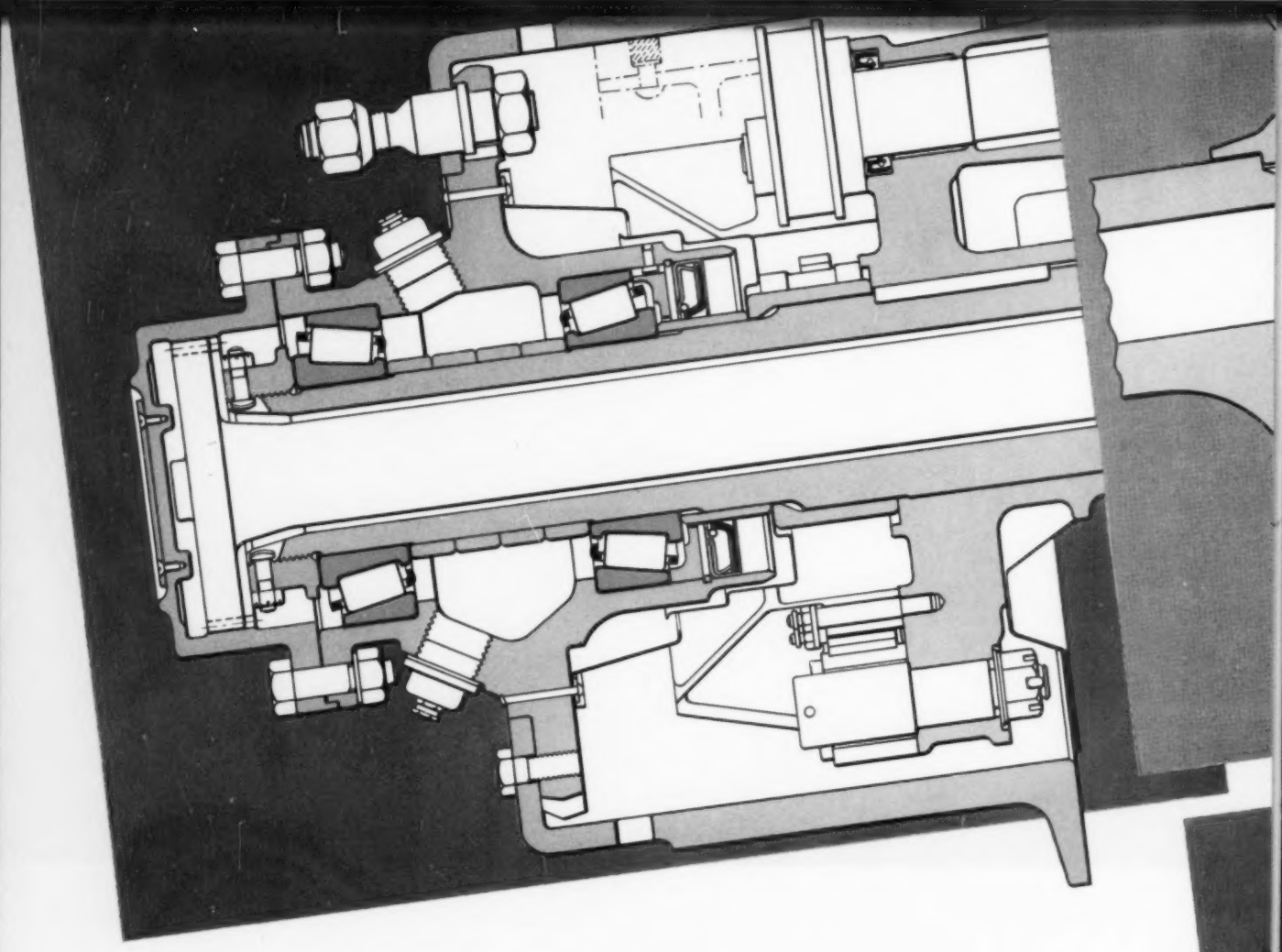

THE A.E.C. 'MAMMOTH MAJOR' Mk.V

In this interesting chassis the drive is taken through the hollow worm of the first rear-axle to an inter-axle differential, driving back to the first worm and through a universal shaft to the second worm.

Steep-angle Timken bearings take the thrust and radial load at one end of the worms, and Timken bearings are used in other situations as shown, including the pivot for the balance beam.

An interesting detail in the rear wheel bearing arrangement is the series of spacers, facilitating selection to the correct bearing clearance, the inner races being locked up tight in the axle.

British Timken, Duston, Northampton, Division of The Timken Roller Bearing Company. Timken bearings manufactured in England, Australia, Brazil, Canada, France and U.S.A.

TIMKEN®

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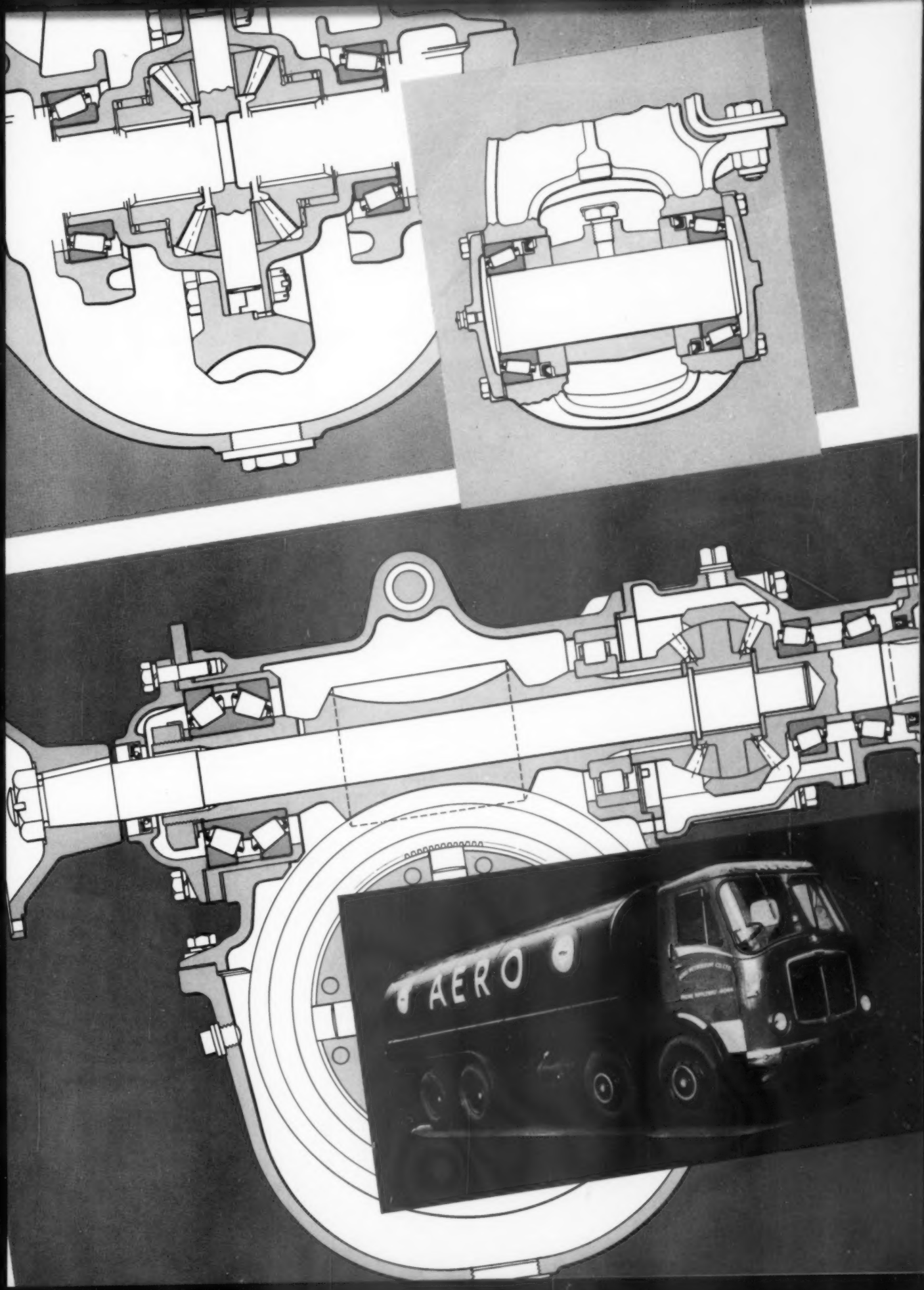
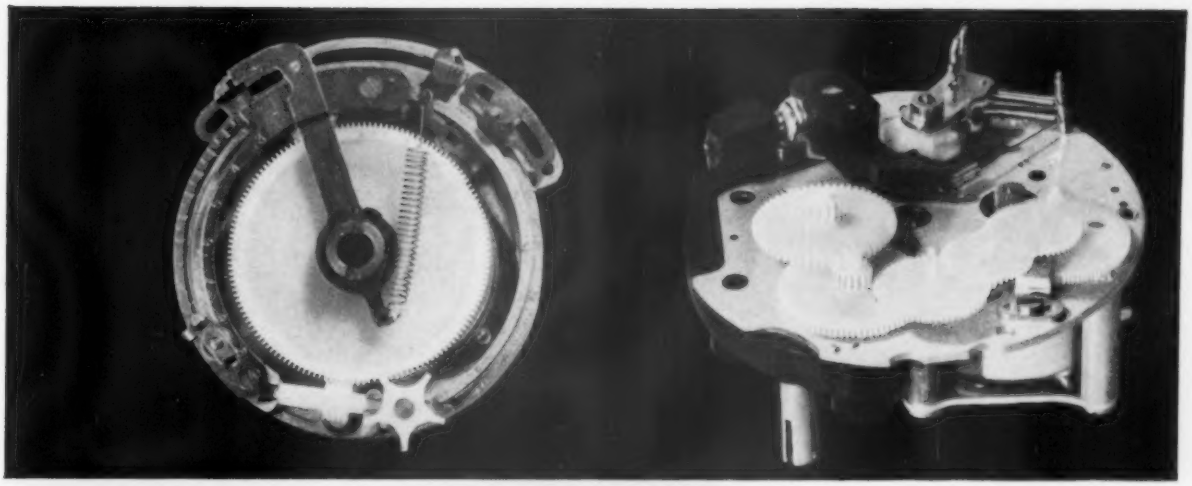
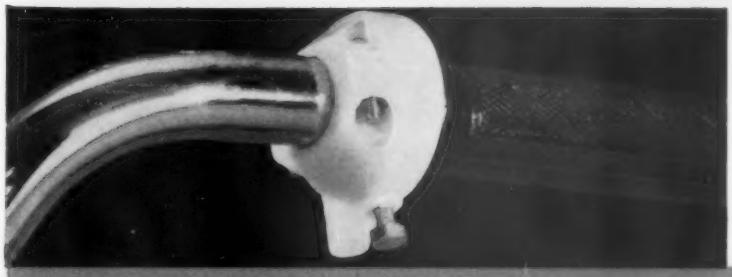
tapered roller bearings


AERO





Gears for time-switch by Sangamo Weston Ltd.; extra dimensional stability and mechanical strength were essential. Moulded Delrin components have replaced brass; production is quicker, less costly

Delrin motor-cycle twist-grip housings, made by J. & E. Courtney Ltd. for Doherty & Ashby. Moulded in various attractive colours, they replace heavier chrome-plated castings, eliminate corrosion problems

In these uses (and many others) Delrin * replaces metal

In a wide range of applications where metal was once standard—iron, steel, brass, aluminium, zinc—DELRIN, the new Du Pont acetal resin, is now being used.

The design and engineering possibilities that DELRIN offers cover a great variety of uses and you will find an increasing number of parts moulded of DELRIN in diverse industries—the automotive, textile, hardware, plumbing and business machine industries, etc. This is because DELRIN combines so many excellent properties—among them strength, stiffness, dimensional stability and resistance to solvents and high temperatures.

DELRIN HAS:

	OVER TEMPERATURE RANGE −40°C +125°C −40°F +258°F
1. High tensile strength	13,000 psi to 4,000 psi
2. High modulus of elasticity	445,000 psi to 89,000 psi
3. Good impact strength	Izod. 1.2 to 1.4 ft.lb/in.
4. Excellent resistance to fatigue	5,000 psi 73°F
5. Resistance to solvents	Good throughout range
6. Abrasion resistance	Good throughout range
7. Moisture absorption	Low throughout range
8. Colourability	Excellent: colours do not affect properties
9. Coefficient of friction (unlubricated)	Uniform at 0.2 ± 0.1

Please send further information on:

☐ DELRIN* —acetal resin
☐ ALATHON† —polyethylene resin
☐ LUCITE† —acrylic resin
☐ TEFLON† —fluorocarbon resin
☐ ZYTEL† —nylon resin

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Plastics

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* **Delrin** is Du Pont's registered trademark for its acetal resin.
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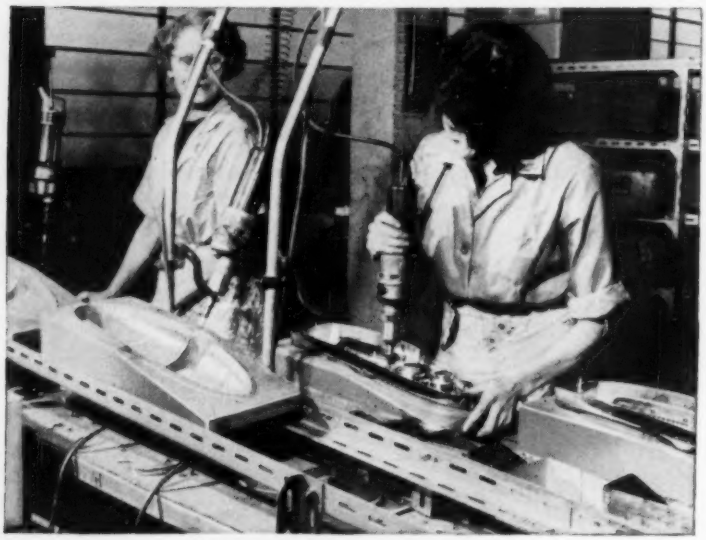
Araldite resins enable manufacturers to produce, speedily and at low cost, assembly jigs which are replicas of original patterns. These jigs can be cast at room temperature and as there is negligible shrinkage on setting, they possess high dimensional accuracy. Araldite is available in forms which will provide any required degree of hardness, and a resilient surface is often used to prevent damage to highly finished products. Araldite jigs are tough, durable and require no maintenance, either in use or in storage. Also, they are much lighter and easier to handle than their metal counterparts. Araldite can probably save you money on your own assembly lines. Let us send you our booklet "Araldite Resins for Tooling".



Araldite faced jigs are used by Butlers Ltd, Birmingham, in the assembly of combined tail and stop lamp shells for cars.

Araldite epoxy resins are used—

For casting high grade solid electrical insulation

for impregnating, potting or sealing electrical windings and components

for producing glass fibre laminates

for producing patterns, models, jigs and tools

as fillers for sheet metal work

as protective coatings for metal, wood and ceramic surfaces

for bonding metals, ceramics, etc.

Araldite *epoxy resins*

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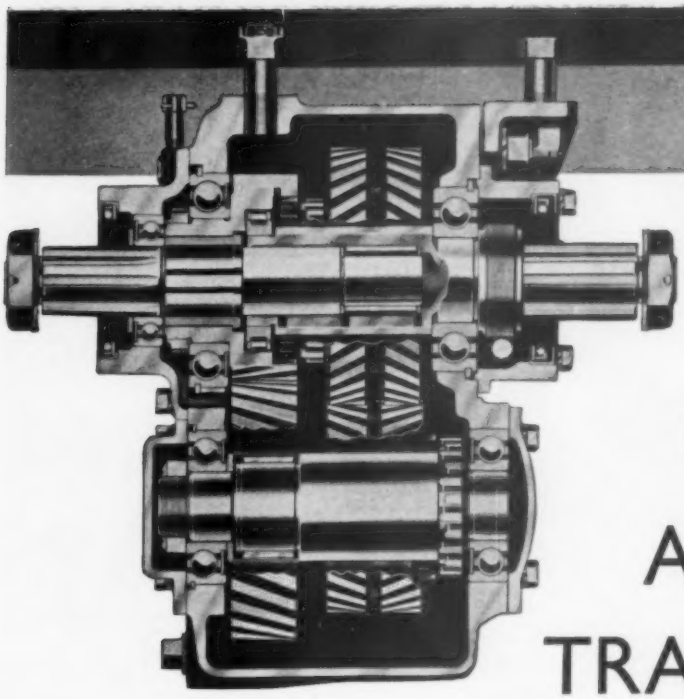

This section of the 2-A-62/2-B-62 two-speed transmission shows the robustness which is characteristic of all Fuller transmissions. Note the generous double-helical constant-mesh gears and the parallel-roller spigot bearing.

FULLER AUXILIARY TRANSMISSIONS

The two-speed box illustrated is suitable for use behind the main gearbox of vehicles having engines of approximately 620 cu. ins. capacity.

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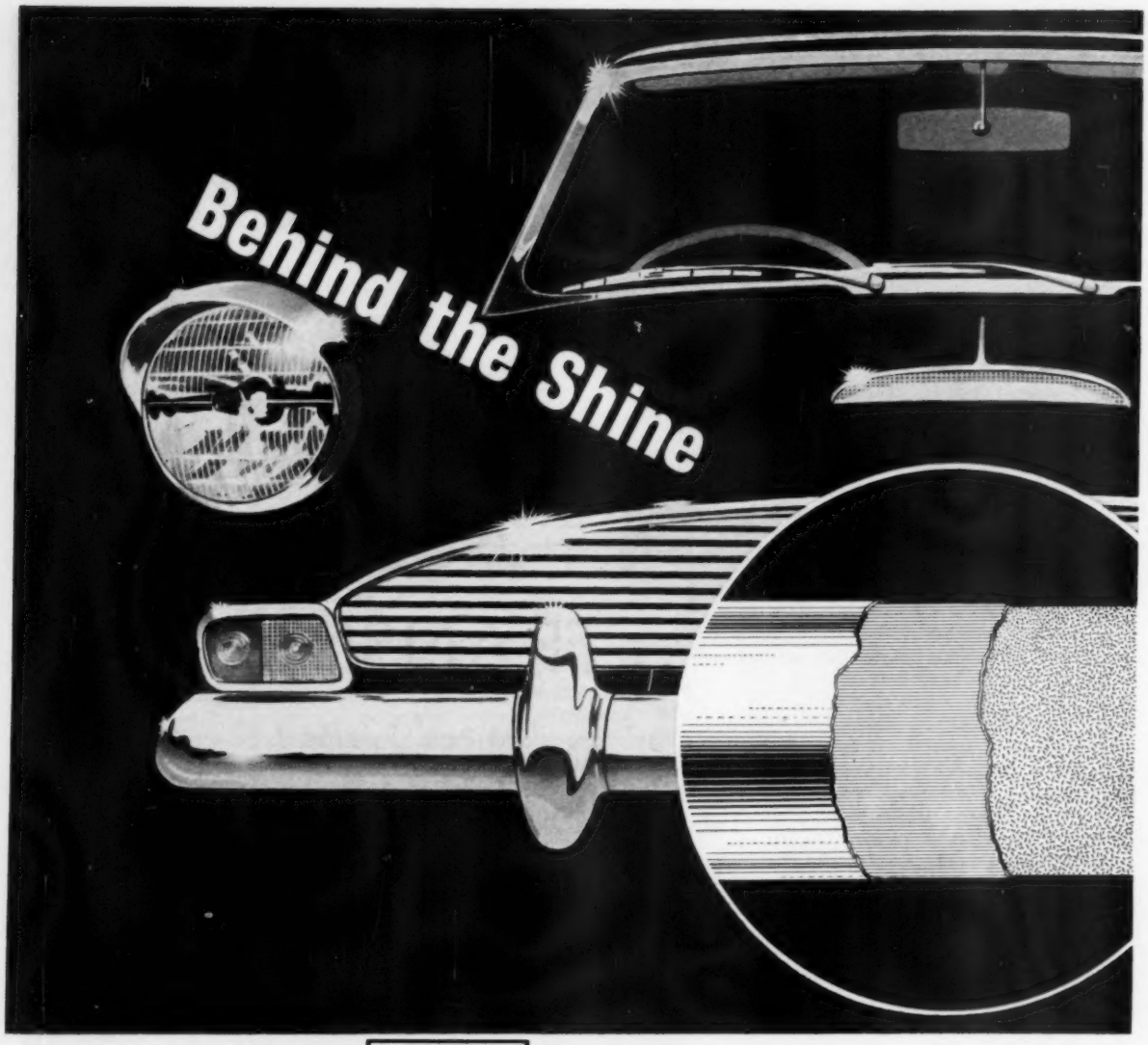
Telephone: Langham 2527 *Telex: 23446*

Sole European Representatives for the Fuller Transmission Division, Eaton Manufacturing Co., U.S.A.

FULLER TRANSMISSIONS

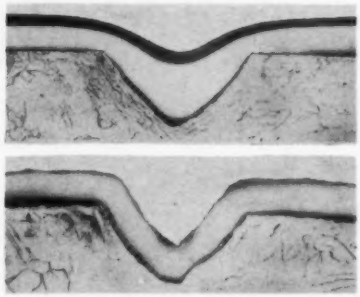


with the HARSHAW PERFLOW PERGLOW DUPLEX *Nickel Plating Process*

THE HARSHAW CHEMICAL COMPANY, after years of research and development work, was the first to find that a sulphur-free nickel gives greater corrosion-resistance. This fact led to the development of the Harshaw Perflow nickel plating process.

Further research showed that use of the sulphur-free Perflow nickel deposit as a base coating, followed by a bright nickel deposit from a compatible bath, would give a Duplex deposit with a further improvement of corrosion-resistance.

Accelerated tests and outdoor exposures by leading car manufacturers and parts suppliers indicate that the Harshaw Perflow-Perglow Duplex nickel plate is comparable to and frequently better than buffed dull nickel and is unequalled by any bright nickel. This process provides the ideal nickel base for first-quality chromium plate.



The above photomicrographs demonstrate the levelling effect of Harshaw Duplex Nickel as compared to that of conventional grey nickel.
Top: *Perflow-Perglow Duplex Nickel-depth of scratch 2·7 mils.*
Bottom: *Grey nickel-depth of scratch 2·7 mils.*

Write for details of this process to

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CP119

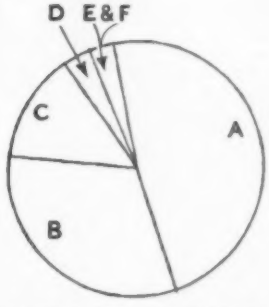
Factory Heating-1

The space heating of factories by electrical means can be achieved in a variety of ways which will be dealt with in the next Data Sheet.

Before deciding on any form of factory space heating—whether by means of electricity or not—it is as well to have clearly in mind all the components of the total annual running cost, and not merely the fuel cost, of the installation.

They are:

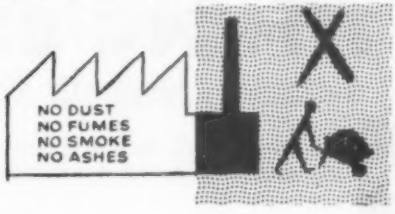
- **(A)** The cost of the fuel or the electricity,
- **(B)** Interest and depreciation on the capital cost of the installation,
- **(C)** Labour,
- **(D)** The cost of running auxiliary plant such as fans and pumps,
- **(E)** Maintenance,
- **(F)** Insurance.



In comparing fuel costs it should be borne in mind that electric heat is refined heat and has had all the fuss, bother and dirt of the conversion of fuel into heat taken out at the generating station.

In arriving at the true figures for capital cost and depreciation, maintenance, and insurance, those connected with such items as boilerhouse, chimney, fuel store and access road should be included; labour costs should include such tasks as ash disposal. None of these items occurs when electricity is used, although space will be required for the electric boiler and storage vessels in the case of the type (h) following.

Electricity provides the ideal answer to the requirements of the Clean Air Act, the impact of which has introduced an important new factor during the last few years.



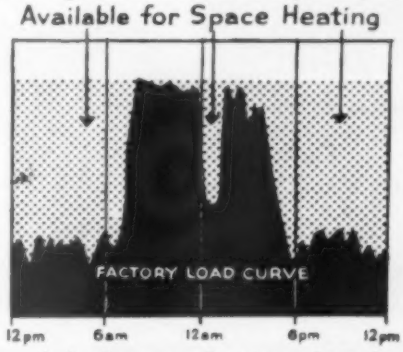
The following list gives the main types into which electric heating installations fall:

- (a) High temperature ("infra-red") overhead heaters operating at near red heat.
- (b) Medium temperature panels operating at surface temperatures of 400° to 600°F.
- (c) Extended surfaced heating in the shape of floorwarming operating at temperatures up to 80°F.
- (d) Oil and water filled radiators.
- (e) Tubular heaters.
- (f) Unit heaters.
- (g) Storage block heaters.
- (h) Electric boilers and water heaters operating in conjunction with hot water radiators or panels either with or without water storage.

All these methods of electric heating can be divided into two distinct classes:

- (a) Those that utilise electricity during "off-peak" hours and store the heat so generated for use at a later period.
- (b) Those that use electricity whenever the heating system is in use (i.e. direct electric heaters).

The use of a heat storage system in a small works on a block tariff takes advantage of the lower tariff offered for an off-peak supply, and in the larger factory on a Maximum Demand tariff means that the heating load will not incur any M.D. charge.



Alternatively there may be cases where the use of direct electric heaters can be integrated with other factory loads in such a way that they are not used during the factory peak periods and will thus incur no additional M.D. charge.

For further information, get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London, W.C.2.

Excellent reference books on the industrial and commercial uses of electricity and reprints of articles and papers are available. An example is "Higher Industrial Production with Electricity" (price 8/6 each or 9/- post free).

E.D.A. also have available on free loan in the U.K. a series of films on the industrial uses of electricity. Film and Book catalogues and Publications List sent on request.

14379

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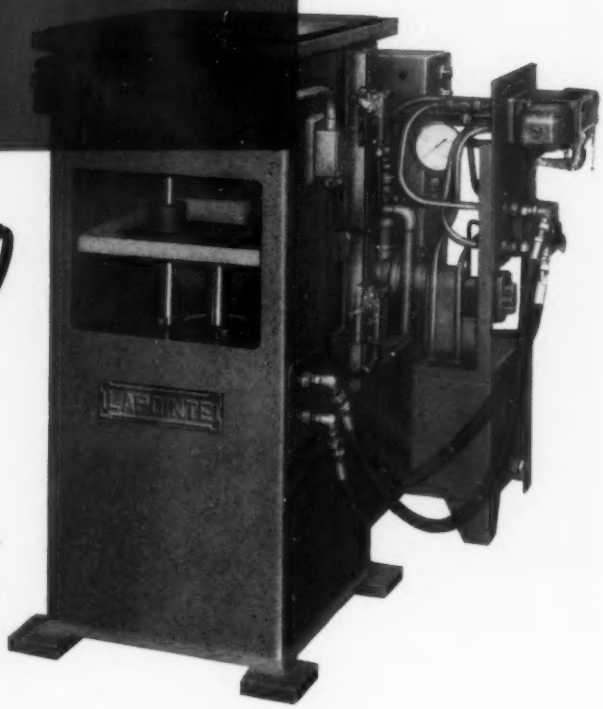

The SPD 7/16 offers traditional Lapointe speed and accuracy in a new, low cost broaching machine. Designed for the rapid production of small components, the SPD 7/16 stands only bench high, weighs only 12 cwt. Delivery time is 2-3 months.

It enables the manufacturer with a limited budget and limited floor space, to profit from Lapointe engineering design and skill for little capital outlay.

SPD 7/16 Pull-Down Broaching Machine
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Stroke: 16 in.
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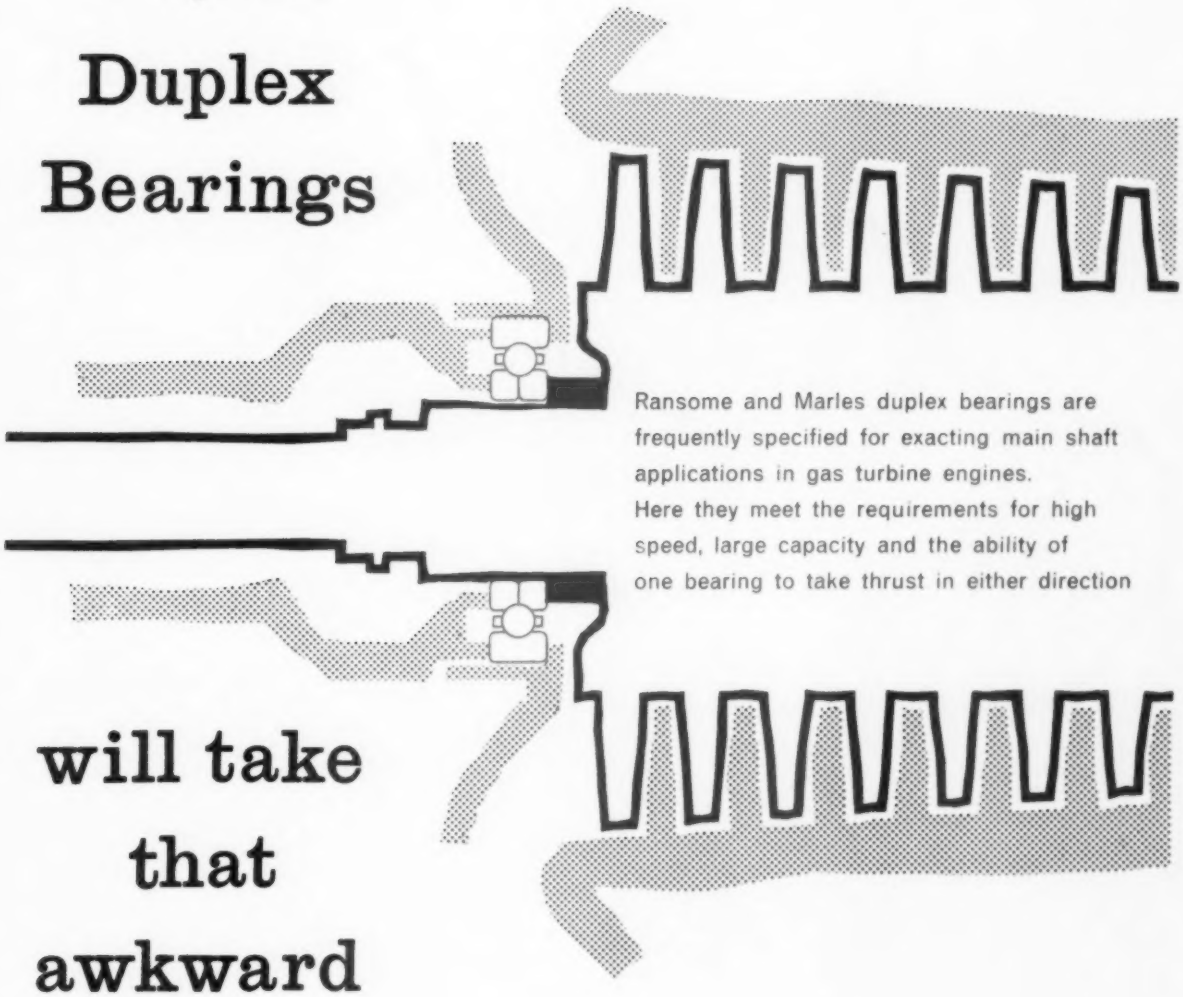
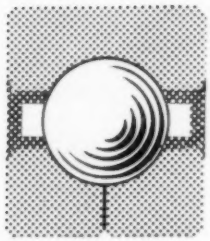
R&M Duplex Bearings



Ransome and Marles duplex bearings are frequently specified for exacting main shaft applications in gas turbine engines. Here they meet the requirements for high speed, large capacity and the ability of one bearing to take thrust in either direction

will take that awkward thrust load



There are many other less critical applications where the duplex bearing is providing a compact solution to thrust problems, as well as for combined loads.

Ransome and Marles pioneered the two-piece inner design and it is now backed by a wealth of practical experience. Publication 37 will provide you with full details of duplex and other bearings in the R&M range

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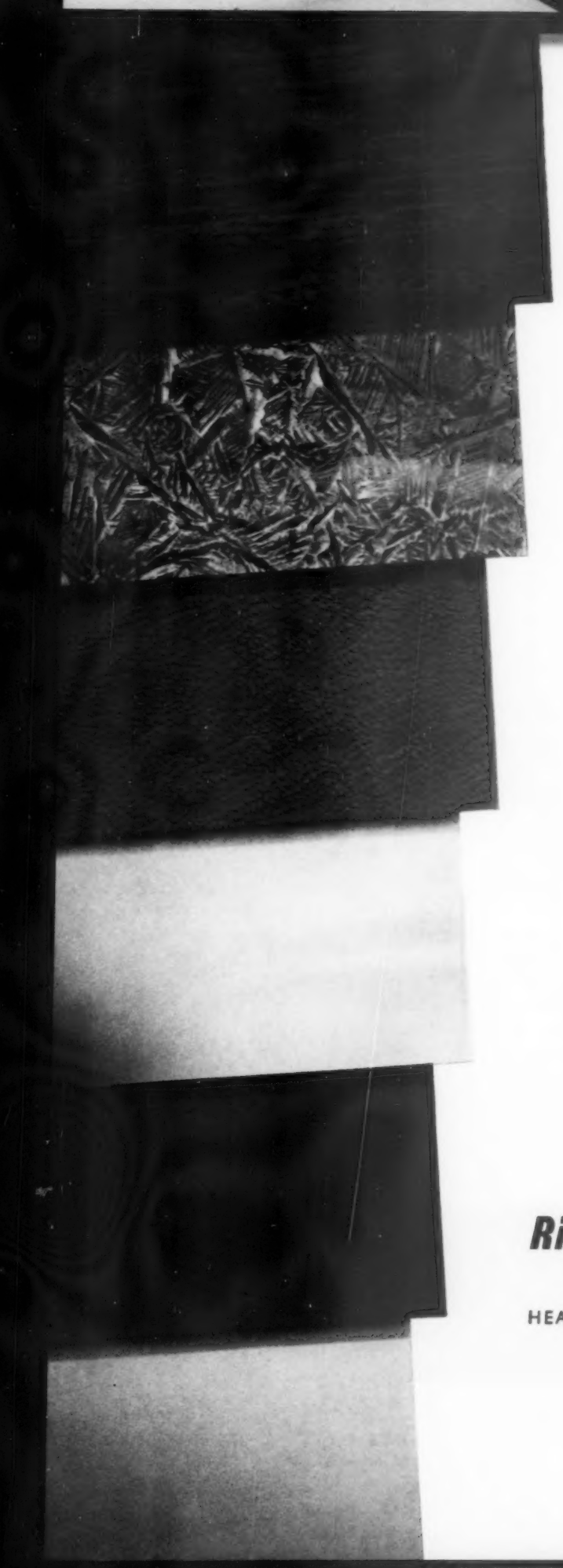

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AUTOMOBILE ENGINEER

CONTENTS

INCREASING INTEREST IS BEING SHOWN BY CAR MANUFACTURERS IN PAIRED HEADLAMP SYSTEMS. THE LATEST FOUR-LAMP INSTALLATION IS THAT OF THE NEW FORD CONSUL CLASSIC 315 CAR, FITTED WITH LUCAS SEALED-BEAM TYPE UNITS

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AUTOMOBILE ENGINEER

DESIGN · MATERIALS · PRODUCTION METHODS · WORKS METHODS

Accelerated Running-in

NOWADAYS the main objective of running-in is simply the stabilization of the oil consumption. By virtue of advances in bearing technology, the large stroke : bore ratios and the oil-retaining and other properties of the cylinder bore finishes widely employed, most engines of vehicles currently in production can safely be subjected to full load very early in their life. Although rough bore finishes were originally introduced to accelerate bedding-in of the piston rings, their potential benefit in this respect has since been offset by the low wear rate of the chromium plated top rings more recently adopted.

The vehicle owner expects an oil consumption equivalent to about one per cent of the fuel consumption, and he tends to become dissatisfied should it not be reduced to this level within the first few hundred miles on the road. If conventional running-in methods are used, he is likely to be disappointed in this respect, so the manufacturer is faced with the alternatives of either giving each engine several hours' additional running on the bed, or adopting some means of speeding the running-in process. Obviously the first measure is impracticable except in the case of engines in relatively small-scale production.

Techniques for accelerating the running-in process are therefore attracting increasing interest, and at least three have so far been developed. Before considering these, however, one should be clear as to the requirements of any technique of this kind: the method must be simple and fool-proof in application; it should give consistent results in all the cylinders of every engine; and it should not have any undesirable side-effects, such as a prolonged increase in the rates of wear in any parts of the engine.

The best-known method is to feed a small quantity of an abrasive powder into the air intake during the initial running of the engine. This has been tried in the U.S.A. with a certain amount of success, but distribution in a multi-cylinder engine is usually inconsistent. Moreover, the abrasive, of course, tends to find its way into the oil.

A greater degree of control is inherent in the second method, which consists of the addition of a fully soluble chemical to the fuel—petrol or diesel—on which the engine is initially run by the manufacturer. During each combustion cycle, the additive drawn into the cylinder with the fuel is converted into a minute quantity of abrasive ash, which serves as the lapping agent. Not only is this additive in no way detrimental to fuel injection equipment, but also, in petrol engines, distribution does not seem to be critical. It is claimed that there is no evidence of any ill effects on the wear rate in general. Unfortunately, the technique is scarcely suitable for running-in on the road: the hardness of the abrasive particles increases with the temperature reached during combustion, which obviously can be closely controlled only in the factory.

In the third technique, developed by a well known piston ring company, a very thin abrasive coating is applied to the working surface of the chromium plated top ring during its manufacture. This coating causes the ring to wear relatively rapidly for a short period, after which it reverts to its normal wear rate; there are the undoubted advantages that the abrasive is confined to the critical component, and that the treatment cannot be continued for too long. It has been shown, also, that no significant quantity of the abrasive reaches the other rings or the lower portions of the engine.

Although the fuel additive and coated ring techniques each have advantages, neither has yet been received with unqualified approval, so other solutions to the problem may be sought. It might be thought that good prospects are offered by the use—perhaps again by the manufacturers—of an oil additive having an action similar to that of the fuel additive already described; as the mating of the rings to the bores improved, progressively less oil would reach the combustion chamber, thus reducing the lapping effect. However, the major difficulty would be that of ensuring that the abrasive did not form at any local hot spots, or in any other way adversely affect the engine components such as valves and bearings.

An important factor is, of course, the additional cost. Of the three methods discussed, the third is probably the most expensive. Even so, the price of a treated ring is only about 20 to 25 per cent more than that of an equivalent chromium plated component of standard type.

Pontiac Tempest Chassis

This Tempest four-door saloon has a 112 in wheelbase, and is available with either a four cylinder or a V-eight power unit

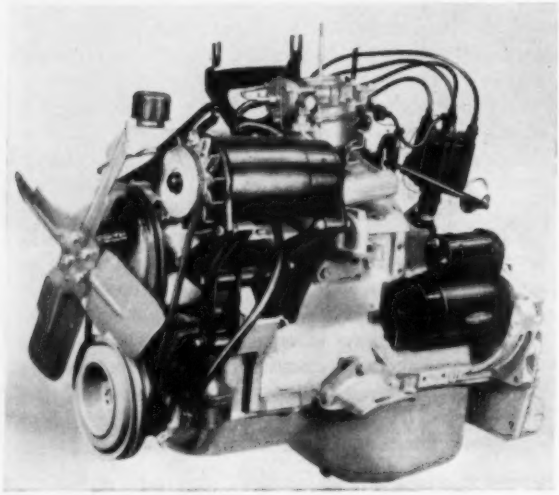
An American Compact Car in Which Several Interesting Innovations Have Been Embodied

By HERBERT CHASE M.E.

AS is well known, compact cars now are invading the medium price field of the American automobile industry. This is partly because of successes achieved by models of this type in the low priced group. An outstanding car in this new class is the Pontiac Tempest. It has several innovations, so far as American practice is concerned, and lays claim to some on a world industry basis.

Especially noteworthy is the use of an inclined four-cylinder engine mounted at the front, with a combined axle and transmission unit at the rear, the latter being mounted on the unitary body structure. This combination affords good weight distribution. Independent coil spring suspension is provided at both the front and rear. Another unusual feature is the use of a hat section torque reaction member joining the engine to the transmission. This is a heavy sheet steel pressing and it houses a slender propeller shaft which is bowed downward so that the body floor is nearly flat and is without a tunnel. Either synchromesh or automatic transmission units can be provided. When the latter is used, the hydraulic torque converter is mounted on the rear of the transaxle.

The four-cylinder engine. When a synchromesh gearbox forms part of the transaxle unit at the rear of the vehicle, a clutch enclosed in a bell housing is mounted conventionally on the back of the engine



There are optional alternative engines. One, the cylinder block of which closely resembles one bank of the 1960 Pontiac V-eight unit, has a swept volume of 194 in^3 and four cylinders with bore and stroke dimensions of 4·0625 and 3·5 in respectively. The other is a new engine of V-eight design with a bore and stroke of 3·5 and 2·8 in and a swept volume of 215 in^3. It is made largely from aluminium so as to keep weight to a minimum, but is rated at 155 b.h.p. at 4,600 r.p.m, with 8·8 : 1 compression ratio. This maximum rated output is the same as that which the four-cylinder engine develops at 4,800 r.p.m, but with a 10·25 : 1 compression ratio, for which premium fuel is required. The standard four-cylinder unit is rated at 110 b.h.p. at 3,800 r.p.m, with an 8·6 : 1 compression ratio, but there are four optional versions rated 120 to 155 b.h.p, all except one of which have a compression ratio of 10·25 : 1. These are advertised maximum outputs, and the peak power is not at the same speed in all cases.

Many components of the four-cylinder engine are identical with those of the 1960 Pontiac V-eight unit of 195 in^3 swept volume, which has a cast iron cylinder block and crankcase, as also does the new four-cylinder engine. This is very convenient in respect of production, because the tools for making the older engine are used and are highly developed for economical manufacture. Components common to the two engines include several parts of the valve train — among them the valves themselves and hydraulic tappets — pistons, connecting rods and head.

The cylinder block, inclined 45 deg to the left, as viewed from the front, is cast integrally with the crankcase. Both the camshaft and carburettor are in the central vertical plane. Mixture feeds down from the carburettor, upward through the inlet manifold and then downward inside the cast iron head to the inclined valves. Coaxial springs are used to seat the valves, which are operated by pressed steel

rockers, tubular push rods, and hydraulic tappets. Four of the five four-cylinder engines have single-barrel carburettors but the fifth, the most powerful model, has a four-barrel instrument.

Pressed steel sumps are employed in all the engines. A 12 V ignition system is used. The distributor is driven by an inclined shaft, towards the rear above the starter. V-belts drive the fan and the generator, pivoted to a bracket fairly high on the right.

Pistons of the slipper type are employed. They are tin plated heat-treated aluminium alloy, and have two compression rings of high strength cast iron, the top ring being chromium plated. The wear surfaces of the oil control ring are similarly plated, but this component is of spring steel and has an expander. A tolerance of $\frac{1}{16}$ oz is quoted for the pistons.

A cast crankshaft of pearlitic malleable iron is used. It has four integral counterweights. The balance is held to 0·50 oz-in and this, together with five 3 in diameter main bearings that overlap the big-end bearings, and the use of a harmonic balancer, lead to smoothness in operation. Heavy sections, large bearings and good support of the crankshaft promote rigidity.

The three-port exhaust manifold serves a $1\frac{1}{4}$ in diameter tube to the silencer. A thermostatic valve is incorporated to deflect exhaust gas for mixture heating. In the silencer, which has tuning chambers and a double wall with asbestos sheet between, the counterflow arrangement has been adopted. The rear end is forward of the transaxle and discharges through a $1\frac{1}{2}$ in diameter tail pipe at the back.

For the aluminium alloy cylinder block and crankcase casting, a semi-permanent metal mould is used but the cores for the water jackets are made from resin bonded sand. The cylinder liners are of alloy iron and are cast centrifugally. Machined serrations on the outer peripheries of the barrels positively anchor the liners when they are cast in the block. Cast alloy iron main bearing caps are used and are said to maintain proper bearing clearances for all temperature conditions. Tapered inserts are employed to form seals between the rear bearing cap and the cylinder block casting.

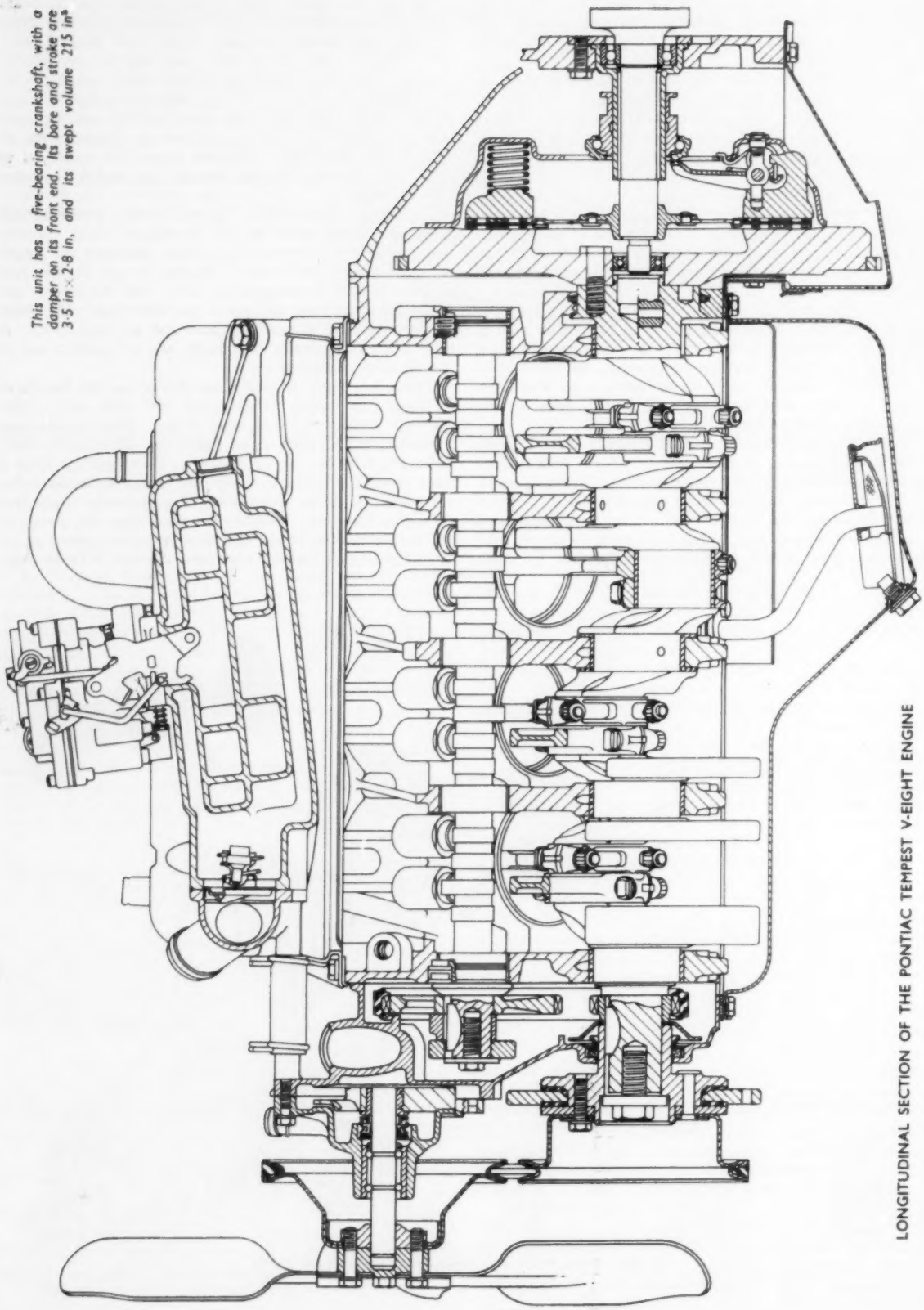
Combusion chambers of approximately part-spherical form are incorporated in the aluminium alloy cylinder heads. Centrally located spark plugs minimize the length of flame travel, and make it feasible to use regular fuel despite the 8·8 : 1 compression ratio. All valve seats are pressed into the head and are of cast alloy iron. The valve guide inserts are also of cast iron and are pressed in. A total of 14 bolts fasten each head, and the gaskets are of the all-steel, embossed type.

The rocker arms are aluminium diecastings but they have sintered iron inserts at the push rod ends and carbo-nitrided inserts at valve stem ends. This construction minimizes inertia forces, permitting the use of a relatively light single spring for each valve. These springs have a high natural frequency. Hydraulic lifters minimize valve train noise. Further suppression of engine noise is afforded by a glass fibre mat, covered with aluminium foil, on top of the central portion of the induction manifold gasket, which is a single, fluted pressing extending between the joint faces

The front and rear end assemblies of the Tempest chassis are interconnected by a pressed steel channel, inside which a slender bowed propeller shaft is housed

THE ENGINE AND TRANSMISSION COMBINATIONS

Standard or optional	*Transmission*	*Compression ratio*	*Carburettor barrels*	*Maximum b.h.p. @ r.p.m.*	*Maximum torque @ r.p.m.*
Four-cylinder in line engine, 4¼ in bore, 3⅛ in stroke, 194·5 in³ swept volume					
Standard	Synchromesh	8·6 : 1	1	110 @ 3,800	190 @ 2,000
Optional	Automatic	8·6 : 1	1	130 @ 4,400	195 @ 2,200
Optional	Synchromesh	10·25 : 1	1	120 @ 3,800	202 @ 2,000
Optional	Automatic	10·25 : 1	1	140 @ 4,400	207 @ 2,200
Optional	Synchromesh or automatic	10·25 : 1	4	155 @ 4,800	215 @ 2,800
V-eight engine, bore 3·50 in, stroke 2·80 in, swept volume 215 in³					
Optional	Synchromesh or automatic	8·8 : 1	2	155 @ 4,600	220 @ 2,400
Axle ratios available: standard, 3·55 : 1; economy, 3·31 : 1, performance, 3·73 : 1					



This unit has a five-bearing crankshaft, with a damper on its front end. Its bore and stroke are 3·5 in × 2·8 in, and its swept volume 215 in³

LONGITUDINAL SECTION OF THE PONTIAC TEMPEST V-EIGHT ENGINE

on each block, and serving also as a cover over the push rod and tappet chambers.

Engine coolant circulating through the intake manifold jacket helps to minimize variations in temperature of the inlet passages under all operating conditions. A diecast aluminium, timing drive cover is used and carries the water pump, whose shaft extends forward to drive the fan. Outlets from the pump lead through this cover to the cylinder jackets.

The overhead valves are inclined relative to the cylinder axes and are actuated by rockers, push rods, tappets and a chain driven camshaft in the base of the V. There are five main bearings, and each of the crankpins carries two big-end bearings. The flywheel, with the starter ring gear, is mounted conventionally at the rear. At the front, is the usual chain and sprocket timing drive and a V-belt for the water pump and fan.

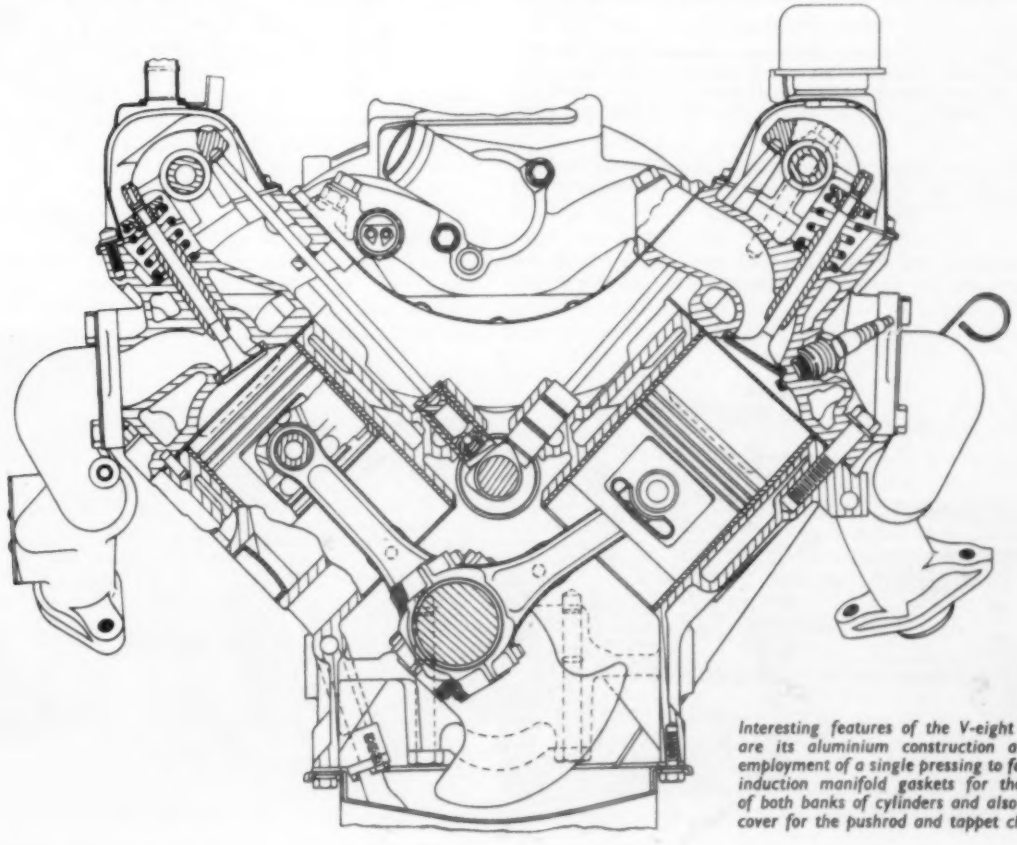
Water drawn from the radiator by the pump is circulated in conventional fashion through the cylinder jackets and head, and also through a thermostat valve to cored passages in the inlet manifold. This manifold has a connection to a heater, whence the water returns to the pump. Since the main casting is of aluminium, dry liners are fitted in the cylinders. The walls of the crankcase extend well below the crankshaft and are ribbed. A pressed steel sump completes the crankshaft enclosure.

Although all the engines are new, engineering interest probably centres principally on the transaxle unit. Regardless of whether the standard synchromesh transmission or the automatic type, with its planetary units, is used, the central assembly is part of the sprung mass. The automatic type is of course heavier and much more complex than the synchromesh unit, but it is preferred by most American purchasers despite higher initial cost and some sacrifice in fuel economy. With the synchromesh type, the lubricant employed is the same as that for the automatic gearbox.

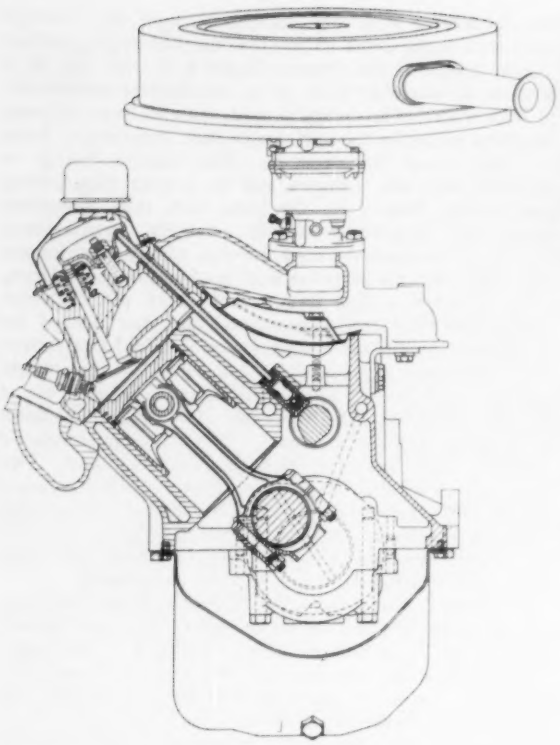
The design of the Pontiac Tempest is such that it is possible to assemble most of the mechanical components to form a sort of frameless chassis, with its front and rear members joined by the stiff torque unit, and then to lower the body on to this structure. This enables Pontiac to assemble both the Tempest and its heavier cars, having conventional frames, on the same line, thus conserving space and simplifying overall assembly arrangements. Besides the hat-section torque member joining the front and rear assemblies, the propeller shaft is of unique construction.

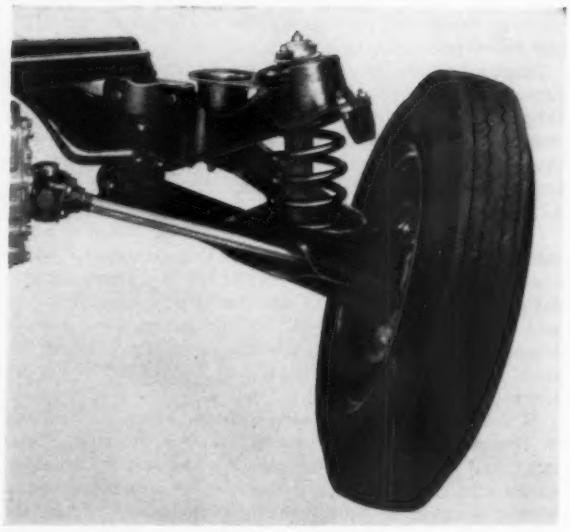
It comprises a long forged shaft, only $\frac{3}{4}$ in diameter, made from alloy steel heat-treated and shot peened for maximum strength and toughness and to afford long fatigue life. This shaft is ground and shot peened in the straight condition and bowed, when installed, until its ends are at an angle of 10 deg to the horizontal. Therefore, it is subject to stress reversals as it rotates. The maximum torque of 189 lb-ft is said to be far below the endurance limit. This shaft has an integral flange at its front end which, when a synchromesh transmission is used, is bolted to a clutch and, when an automatic transmission is employed, is bolted to the engine flywheel. In either case, the rear end of the shaft is splined where it fits into the transmission.

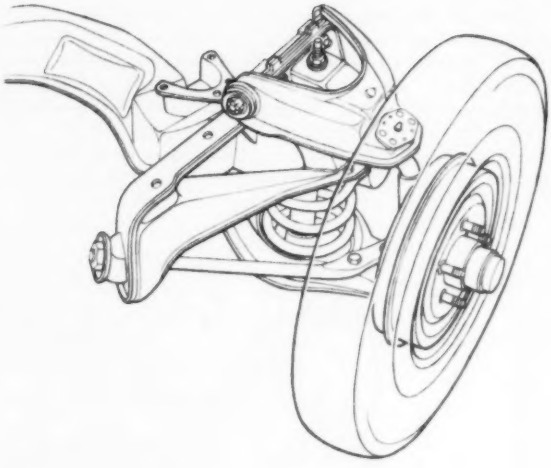
The bowed shaft is supported in special damper bearings, lubricated for life and mounted inside the torque channel. Its assembly is of interest. Each bearing is of the single-row ball type, and both the inner and outer races are rubber mounted. On assembly, a rubber sleeve is slid over the shaft, then a divided steel sleeve is placed round it. Next, the halves of this sleeve are compressed on to the rubber so that the bearing can be assembled over them. The outer race is carried in a thick U-section rubber ring housed



Interesting features of the V-eight engine are its aluminium construction and the employment of a single pressing to form the induction manifold gaskets for the ports of both banks of cylinders and also as the cover for the pushrod and tappet chamber





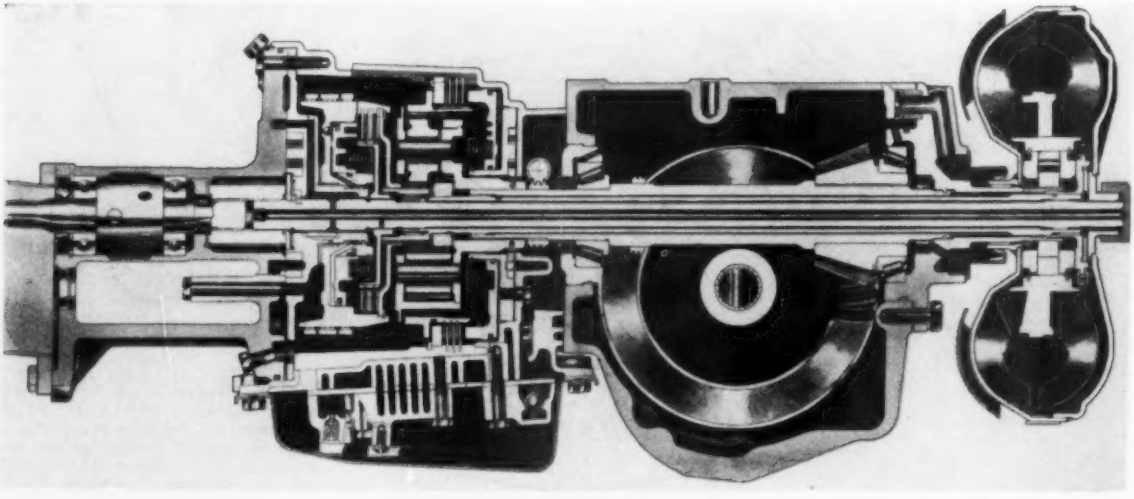


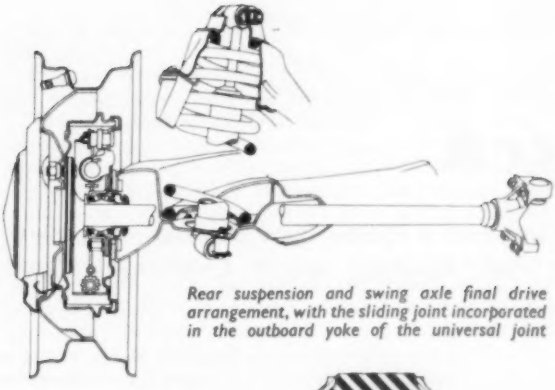
Above: Transverse section of the Tempest inclined four-cylinder engine, the design of which is basically similar to that of the V-eight unit, but with one cylinder bank omitted; they have many common components

Above, right: This illustration of the rear suspension shows how the swing axle passes through an aperture in the fabricated pressed steel A-link. With this suspension arrangement, which includes a coaxial coil spring and telescopic hydraulic damper, the unsprung weight is small

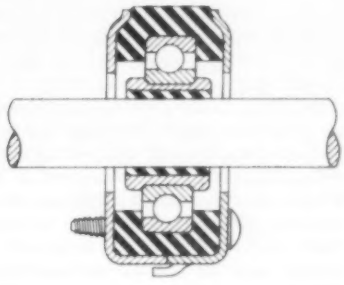
Right: Diagram showing the general layout of the front suspension. The nut on the end of the drag link is used for the adjustment of the castor angle, although there is rubber between it and the bracket

In the transaxle unit, the planetary gear trains are in front of the differential unit, and the air-cooled three-stage torque converter behind





Rear suspension and swing axle final drive arrangement, with the sliding joint incorporated in the outboard yoke of the universal joint



Details of the steady-bearings for the long, bowed propeller shaft

within two cup shape pressings secured together by set bolts, parallel to the shaft, passed through one pressing and the rubber ring, and screwed into the other pressing, as shown in the illustration above.

When a synchromesh transmission is installed, it is bolted to the differential housing and its output shaft drives the bevel pinion. Shifting then is done with a floor-mounted lever, actuating a shaft that can be rotated and moved longitudinally in conventional fashion. The gear ratios are 1 : 1, 2·94 : 1, 1·68 : 1 and 3·32 : 1 in reverse.

With an automatic transmission, the transaxle assembly includes a two-speed planetary transmission having its housing forward of and integral with that of the differential carrier. Seals prevent oil from the differential from seeping forward to the transmission gear unit or rearwards to the torque converter.

This is said to be the first design having a front mounted engine together with a divided torque, automatic gearbox and converter type transmission at the rear. The major units of the transmission are the light-weight three-element air cooled converter at the rear of the assembly, and two planetary units with their clutches and control valve in a housing between the differential and the splined rear end of the propeller shaft. Hollow shafts passing through the differential housing connect the automatic gearbox and torque converter.

In high gear, the drive is split, about 40 per cent of the torque being transmitted mechanically and the remainder through the converter. When the driving speed is below 25 m.p.h, at part throttle setting, automatic down-shift to low occurs if the accelerator is moved to about half throttle. Up-shift occurs subsequently at 35 to 40 m.p.h. Full throttle down-shift is obtained at about 45 m.p.h. Manual down-shift at speeds below 50 m.p.h. provides for overrun braking in mountain driving. The lever for shift selection is on the instrument panel; its positions are reverse, neutral, drive and low.

Many original features are found in the all-independent suspension system, which includes a helical spring near each corner of the unitary body. As a result, the unsprung weight is low, and excellent riding qualities are said to be attained. The layout of the suspension system can be seen from the accompanying diagrams. At the front, the double transverse link system, with coil springs and telescopic dampers, is mounted on a cross member. The upper link is of wishbone form; and the lower one is a simple beam incorporating the seat for the coil spring, and it is used in conjunction with a drag rod made from bar stock. Both transverse links are of fabricated pressed steel construction, and rubber bushed bearings are employed at their inner ends. The outer bearings are ball and socket joints, with phenolic resin cup components. The outer end of the drag strut is swaged and bolted to the hub assembly, and its inner end is threaded to receive the nuts and washers by means of which adjustment is made to the castor angle. This end of the strut is rubber mounted on the main structure.

At the rear, a cross member, arched to pass over the transmission, is secured to the body at four points. Rubber mountings are interposed between it and the transaxle assembly. A swing axle layout has been adopted, with universal joints and splines at the inboard ends of the shafts. The wheel hubs are carried on fabricated pressed steel A links, to which they are secured by four studs. Coaxial coil spring and shock absorber assemblies are interposed between these links and the cross member.

For the saloons and the station wagons, 600—15 and 650—15 in tyres are fitted respectively. The wheelbase and track are 112 in and 57 in and the overall length and width of both versions are 189·3 in and 72·2 in. A height of 53·5 in is quoted for the saloons and 54·3 in for the station wagons.

Standardized Circlips

A WIDE range of circlips, to British, European and American standard specifications, is now in production by Anderton Springs Ltd, Bingley, Yorks. The components are suitable for shafts and bores from 0·39 in (1 mm) to 20 in (508 mm) diameter. Orders from this standardized range can be supplied from stock.

The components are treated so that their final hardness value is 53 Rockwell C and the Izod impact resistance figure is 1·65 ft-lb. Consequently, they are especially suitable for applications where shock resistance is essential. Special tools, including Quick Load Stack Feedas, designed for automatic feeding of certain types of circlip, can also be supplied. In addition, for experimental and development departments, packs of assorted circlips are available. Further information, including technical data and a disc type calculator for circlip specification, can be obtained from the manufacturers.

Standard for Grease

SPECIFICATIONS for calcium-base greases are rationalized in B.S.3223 : 1960. This new Standard makes provision for a range of greases that all have the same general composition and quality but differ in respect of the consistency and of the viscosity of the lubricating oil component. Twelve categories of grease—three different consistencies for each of four oil viscosity ranges—are specified, sufficient to cover all the relevant operating conditions.

Among the specified requirements are the composition, consistency, change of penetration on prolonged working, drop point, free acidity and alkalinity, water content, oil separation and copper erosion. An appendix gives information on the suitability of greases for dispensing from lubricating equipment. Copies of B.S.3223 : 1960 are obtainable, price 7s 6d each, from the British Standards Institution, Sales Branch, whose address is 2 Park Lane, London, W.1.

S.C.G. Fluid Clutch

A Compact Unit, for Use with a Wilson Type Gearbox, Combining the Advantages of a Fluid Coupling and a Centrifugal Clutch

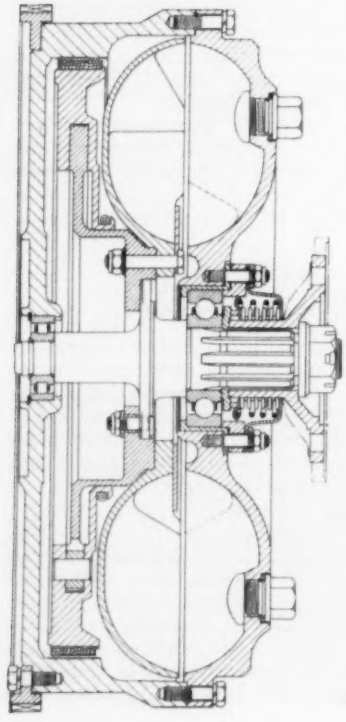
ON motor vehicles fitted with Wilson epicyclic gearboxes, it has, in the past, been customary to interpose between the engine and the gearbox one or other of two types of automatic coupling. Of the two types, the more familiar is probably the hydrokinetic coupling, commonly known as the fluid flywheel, the other being the centrifugally engaged friction clutch. Although reasonably satisfactory in normal use, the hydrokinetic coupling suffers from two inherent disadvantages: there is some drag when the engine is idling, and a degree of slip during power transmission. This slip is most marked during acceleration, but even at a sustained high speed it is still of the order of 2 per cent, which clearly results in a significant wastage of fuel.

A centrifugal clutch, on the other hand, frees completely at idling speeds and engages positively when under load. However, the take-up of the drive from rest is less smooth than is that of the fluid coupling, and wear of the mechanism can result in hunting or judder. In addition, the disengagement of the clutch is frequently less rapid and complete than is desirable, and starting the engine by towing or coasting is impossible, unless an over-run freewheel is fitted. There are difficulties, too, in obtaining engagement characteristics appropriate to the type of vehicle concerned. If the parts actuated by centrifugal force are relatively heavy, to give a positive take-up of the drive at low speed, the clutch action tends to be too abrupt, whereas with lighter parts the engine speed for full engagement of the shoes is likely to be unduly high.

With the object of overcoming these various disadvantages, an interesting new coupling has been designed by Self-Changing Gears Ltd, of Coventry, the manufacturers of the Wilson gearbox. This unit, which is known as the Fluid Clutch, was mentioned briefly in the review of the London commercial vehicle exhibition, published in the November 1960 issue of *Automobile Engineer*. It embodies a hydrokinetic coupling and a centrifugal type friction clutch that is responsive to the speed of the coupling output member. The two assemblies are mounted in tandem within a casing that is no longer than would be that of a normal fluid coupling. Consequently, there is no difficulty in installing the unit in place of an orthodox coupling in an existing type of chassis.

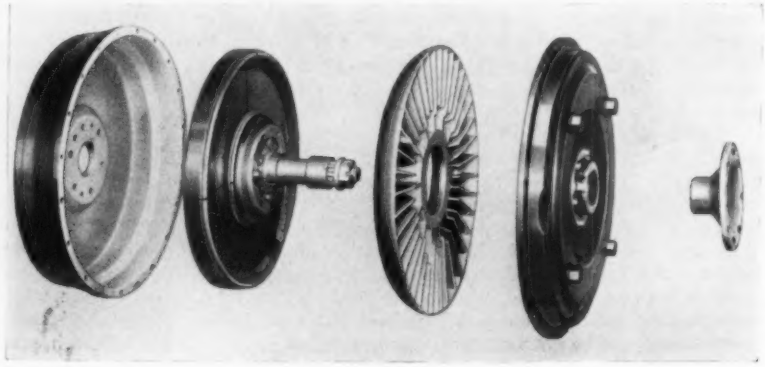
Constructional details

As in cases where a hydrokinetic coupling only is employed the engine flywheel has a deep axial flange, projecting rearward from the periphery of the disc portion. To the rear edge of the flange is bolted the input member of the coupling. The half-toroid of this member faces forward and, for reasons that will be explained later, is of shallower section than would be the case if the friction clutch were not incorporated. In the hub of the input member is housed a large-diameter ball bearing to carry the rear end of the output shaft, from which the drive is transmitted to the gearbox. The leading end of this shaft is of reduced diameter and is pressed into the inner race of a roller bearing, of relatively small diameter, housed in a shouldered counterbore in the flywheel. An external circlip retains the inner race against the shoulder on the shaft, and an internal



A typical S.C.G. Fluid Clutch unit, shown in longitudinal section. The fluid coupling is of shallower form than is customary, and the shoe carrier member of the friction clutch is mounted on the runner

This view of the major components of the Fluid Clutch shows the basic simplicity of the unit. The four shoes of the centrifugal clutch engage against the resistance of a garter spring



circlip performs a similar function for the outer race in its housing.

Part-way along the output shaft is a flange, which forms the locating spigot for the forged steel shoe carrier member of the centrifugal clutch; this member is situated ahead of flange and is secured to it by a ring of uniformly spaced bolts. On the rear face of the member is machined a male spigot, of larger diameter than the attachment flange, which registers in a female spigot on the front face of the runner of the fluid coupling. The bolts securing the runner to the shoe carrier also retain an annular baffle plate that is carried on the rear face of the hub portion of the runner and projects outward into the fluid chamber. There are the usual small clearances between the halves of the coupling and between the runner and the flywheel flange. The two sets of bolts mentioned are fitted with stiff-nuts.

Because of the shallow section of the coupling, there is a space between the coupling runner and the disc portion of the flywheel. The shoe carrier member is in the form of a flanged drum; the flange is at the open end, which is also the leading end, of the drum, and it projects radially into this space. In the flange are four equally spaced radial slots, in each of which a slipper block is a sliding fit. The four shoes are of quadrant shape and are slotted, as viewed in side elevation, to enable them to fit over the periphery of the carrier flange, which thus locates them axially. Each shoe is guided radially by a steel pin, which is supported in it at each end and passes through the slipper block just mentioned. The pin is secured by light peening of its ends.

On the periphery of each shoe is bonded a strip of friction material, of a type having a relatively high coefficient when run in oil. In the engaged position of the clutch, the friction facings of the shoes contact a drum machined within the flange of the flywheel. To increase the contact area, this drum has a circumferentially serrated section. A very simple pull-off system is employed to disengage the shoes when the speed of the output shaft falls. Behind the flange of the shoe carrier, the inner end of each shoe terminates in a foot that, as viewed in end elevation, has a curvature similar to that of the exterior of the drum portion of the carrier. As can be seen from the drawing reproduced, the foot has a lipped section, and a garter spring fits into the circumferential channel formed by the lips on the four shoes.

At its rear end, the output shaft is splined and threaded to accept the output flange and its securing nut. When the nut is tightened, the inner race of the previously mentioned ball bearing is trapped against a shoulder on the shaft by a washer interposed between the race and the boss of the flange. To facilitate assembly, the bearing outer race is not housed directly in the input member of the Fluid Clutch. Instead, it is pressed into a sleeve that has an inwardly projecting flange at its leading end and an outwardly projecting one at the other. The first of these flanges, of course, forms an abutment for the race, and the second provides a means of securing the sleeve to the input member, into the bore of which it is a push fit.

Screwed into the rear face of this member are six studs, which pass through the attachment flange of the sleeve. Over them is next installed a distance ring, on which is a male spigot that enters the sleeve and traps the outer race of the bearing. The studs also serve to attach the domed cover of the spring-loaded oil seal assembly. Stiff-nuts are fitted to the studs, to retain the sleeve, ring and cover.

There is an appreciable running clearance between the boss of the output flange and the hole in the rear of the oil seal cover. Within the cover is a helical spring embracing a metal bellows, which in turn surrounds the boss. At their rear ends, the spring and the bellows abut against the cover, and their leading ends bear on an annulus, which is dished to provide a seating for the spring and for a bronze sealing ring; this ring is situated ahead of the annulus and is pressed by the spring against the rear face of the washer between the bearing inner race and the boss. The annulus is situated within the bore of the distance ring mentioned in the previous paragraph, and the radial clearance between its periphery and the bore is very small, whereas that between the hole in the annulus and the boss of the output flange is relatively large.

The axial length of the complete unit is no greater than that of an orthodox fluid coupling designed to fulfil the same duty

Method of operation

When the engine is idling, with the output shaft at rest, the clutch shoes are held out of engagement by the garter spring. Because of the shallow section mentioned earlier, the fluid volume of the coupling is about one-third less than that of a normal coupling for the same duty. It follows that the transfer of kinetic energy from the input member to the runner is also less for any given speed, so the idling drag is minimized. For the same reason, the torque transmitting capacity at high speed is reduced, the friction clutch making up the deficiency.

As the engine speed is increased from idling, the drive is automatically and smoothly taken up by the fluid coupling. Beyond a certain output shaft speed, centrifugal force overcomes the resistance of the garter spring, and the shoes move outward into contact with the flywheel drum. From this point upward in the speed range, the efficiency of the fluid coupling is unimportant because the increasing grip of the shoes soon causes the drive to become solid.

The mounting of the friction clutch shoe carrier on the output member of the unit ensures that full engine braking is available down to idling speed. If the shoes were mounted on the input member, they would, of course, have a greater tendency to come out of engagement on the over-run. The arrangement adopted also permits a dead engine to be started by towing, and eliminates stalling while on the move.

Tape Reader

THE Creed model 92 tape reader has been designed to meet the need for an inexpensive, medium-speed input device for use in a variety of punched tape control, data processing and automation systems. This unit will operate at speeds up to 20 characters/sec, approximately 200 words/min, and it can be supplied for reading 5, 6, 7 or 8 track paper tape. Either a single or simultaneous double current output can be delivered on a multi-wire parallel basis. Three sets of control contacts, additional to those essential to the operation of the unit, are provided as standard equipment. One indicates when the tape has moved forward and is being read, another signals the control equipment if the tape breaks, and the third stops the feed action if the tape tightens. The size of the unit is $5\frac{7}{8} \times 9\frac{1}{16} \times 4\frac{3}{8}$ in, and its weight is 7·8 lb.

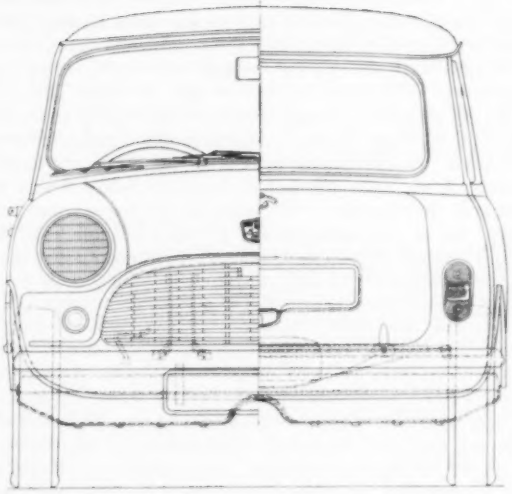
B.M.C. ADO 15

Part III: The Unitary Structure of the Three Available Types of Body, and the Electrical Equipment

The rear sub-assembly of the body shell, showing the central tunnel in the floor and the cross member of top hat section; the stowage boxes flanking the rear seat pan connect the heel-board and the wheel arches with the B pillars of the sides

IN general, the design of the all-welded unitary primary structure of the various ADO 15 models is based on principles established by B.M.C. over the past decade. However, because of the short wheelbase, the construction is unusually simple, with the result that the bare body shell of the car weighs only 310 lb. Even with the sub-frames bolted in position, the weight is only 435 lb, and in this condition the torsional stiffness, measured over the wheelbase, is satisfactorily high, at 8,450 lb-ft/deg. The estate car and van versions—both of which are 10 in longer overall and have a 4 in longer wheelbase than the saloon—have bare weights of about 420 lb and torsional stiffnesses in the region of 6,874 lb-ft/deg.

Although the same basic constructional methods are employed in all three bodies, there are, of course, considerable variations in detail to suit the different functions. In the interest of economic production, virtually the entire structure ahead of the B pillars is common, with only minor exceptions in the case of the roof, sides and front panel. Further aft, quite a number of the pressings are standardized. For simplicity, the construction of the car will be described first, after which an outline will be given of the points of difference of the other two bodies.



General arrangement of the ADO 15 car. The wheelbase is 6 ft 8 in, the front track 3 ft 11⅜ in and the rear track 3 ft 9⅞ in, while the overall length, width and unladen height are respectively 10 ft, 4 ft 7 in and 4 ft 5 in. A frontal area of 15·4 ft² and a kerb weight of 1,260 lb are quoted by the manufacturers, and the ground clearance is 7⅛ in

Car body construction

There are two main sub-assemblies—the front end and the floor portion. They are welded together before the sides, rear panel and roof are added. A major departure from previous B.M.C. practice is the use of externally flanged joints all round the side panels, as a means of facilitating production. After the initial attachment of the sides by widely pitched spot welds, these joints are wheel welded except in the corners, where it is necessary to use gas and spot welding. A capping channel is subsequently fitted over the joints, to improve appearance and sealing. Sheet steel of 20 s.w.g. is employed for most of the pressings, but 18 and even 16 s.w.g. material is specified in highly stressed regions. All the pressings and sub-assemblies are produced by Fisher and Ludlow Ltd. This company completely assembles the Mini-Minor bodies, but assembly of the Austin Seven units is completed at Longbridge.

In effect, the front sub-assembly forms the complete body shell ahead of the A pillars. It consists of the front panel, wings and their valances, dash, toe-board, scuttle and windscreen frame. The front panel is pierced to accept the bolted-on radiator grille, which differs as between the Austin Seven and Morris Mini-Minor models. To it, near the bottom, is spot welded an external, transverse member of 18 s.w.g. angle section, to which the bumper is attached; any impacts on the bumper are taken almost directly by the front sub-frame, which picks up on the panel towards each side. The lower edge of the panel is lipped outward to form the leading part of the full-length external flange that outlines the wheel cut-outs and the bottom edges of the side panels. An internally flanged joint is employed between the front panel and each wing pressing.

At their rear edges these wing pressings have external flanges for welding to the body sides; the flanges are inclined to form downward extensions of the lines of the windscreen pillars. Between each flange and the vertical portion of the A pillar, below the waistline, is a skirt panel that embodies the rear part of the cut-out for the front wheel. The rear

edges of the skirt panels are turned inward for spot welding to the rear valances of the wings.

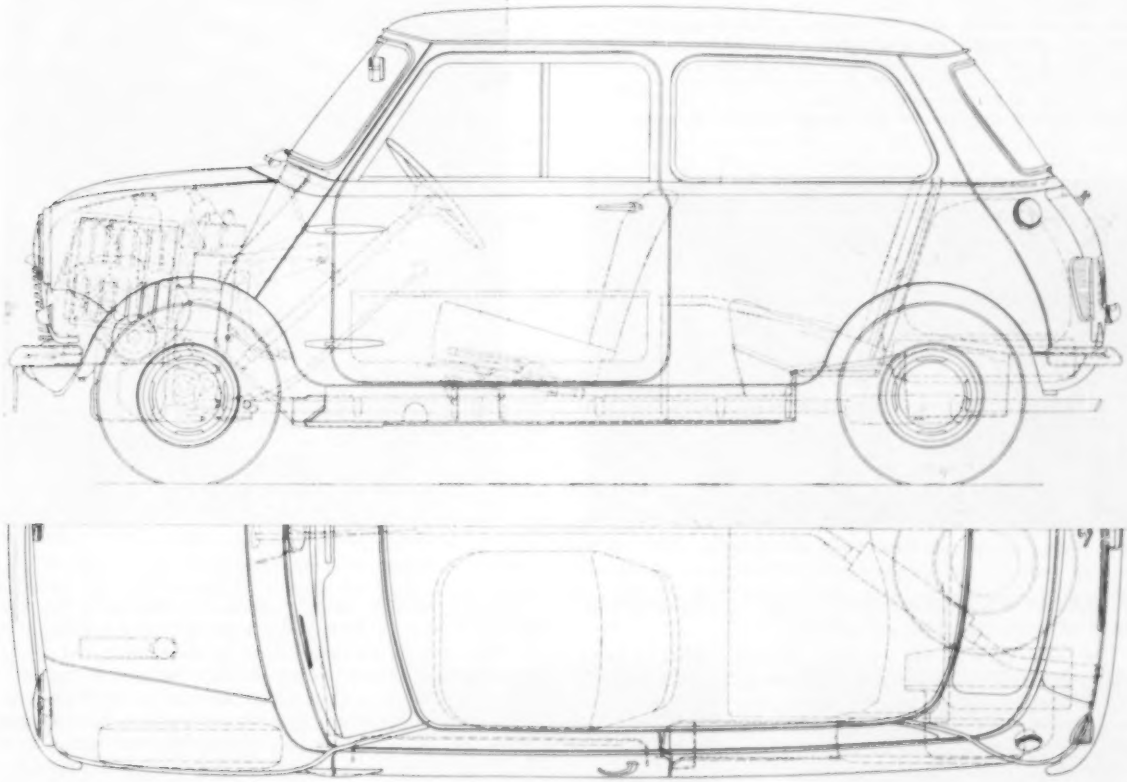
These valances are clearly shown in two of the accompanying illustrations. Each extends downward from the scuttle rail to the bottom of the sub-assembly, and its vertical rear edge is turned outward and then back to form part of the A pillar. Inboard of this edge the valance has an initial inward and forward inclination, as viewed in plan, followed by a bend into the longitudinal direction. The longitudinal portion meets the rear edge of the inner valance, which extends forward to the front panel.

To clear the front sub-frame and suspension, the bottom edges of the valance assemblies are cut away. These edges have stiffening lips, and the top edges are also lipped, for welding to those of the wing pressings. The left-hand inner valance incorporates fourteen pierced and lipped slots, in two rows of seven, through which the air leaving the radiator passes into the wheel arch. To reduce the leakage gap between the radiator and the outlet, a rectangular frame of angle section is welded to the inboard face of the valance, surrounding the slots.

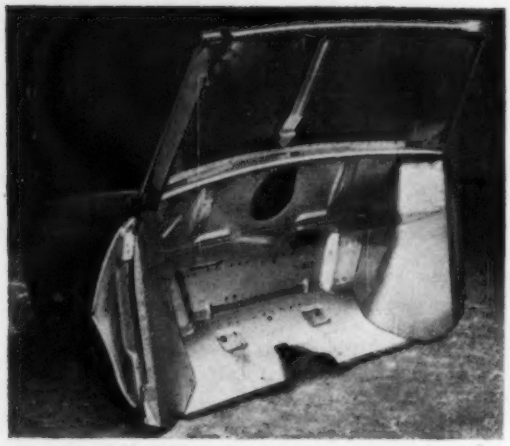
The bridge between the rear ends of the valances consists of the toe-board and dash; the first of these is of 18 s.w.g. material, and to its underside is welded a 16 s.w.g. cradle, on to which the steering rack is clamped by means of two U-bolts. To minimize the constructional differences between cars with left-hand and right-hand drives, the toe-board is symmetrical about its longitudinal axis. At each side, the pressing has a down-turned flange for spot welding to the appropriate valance.

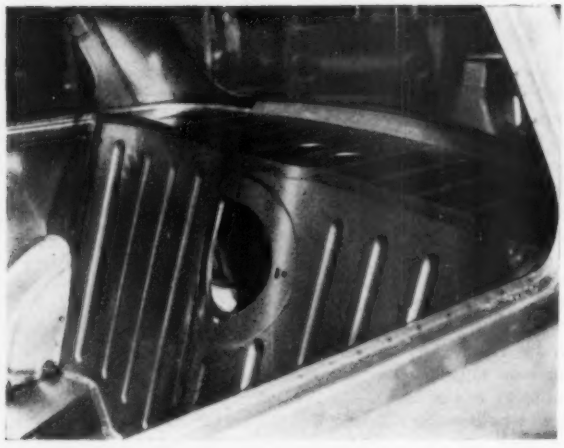
Along its upper edge, the toe-board is spot welded to form a lap joint with the lower edge of the dash panel, which is flanged at both sides and welded to the valances. The lower portion of the dash is vertical, and at each side its section embodies a rearward step, to accommodate the turret brackets of the sub-frame. The upper portion, however, has a rearward rake, and towards the top it is of concave shape—as viewed from the rear—to correspond with the curvature of the windscreen. At the top of the vertical part of the dash, on its leading face, is the welded-on transverse member that sits on top of the turret brackets of the sub-frame, to which it is bolted. This member is a 16 s.w.g. top hat pressing. Its depth increases towards the ends, which are welded to the wing valances, each joint being reinforced by a vertical triangular gusset plate with a lipped edge.

A minor structural function is served by the full-width parcel shelf, which is situated immediately behind the transverse member just mentioned. The shelf is flanged where it is welded to the dash and the rear valances of the wings, and it is stepped up along the middle to increase its rigidity. Mid-way between the ends of the dash panel, above the shelf, is a large hole to accommodate the spit used in the Rotadip priming of the Mini-Minor bodies; the priming of the Austin Seven bodies is done in a slipper-dip plant in the Longbridge factory.

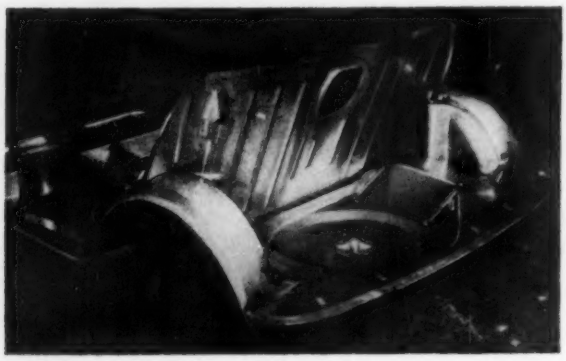


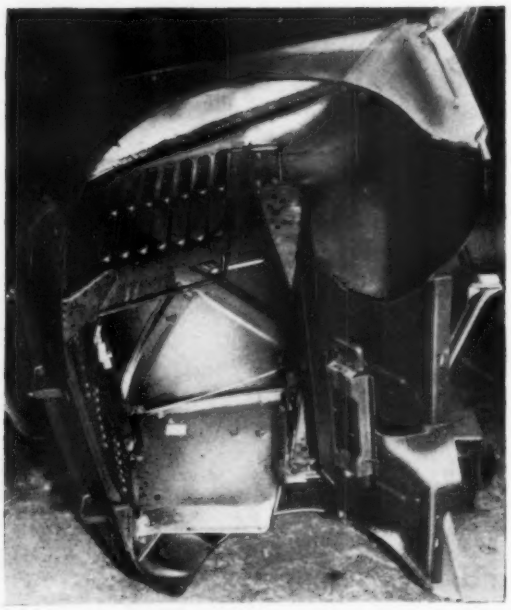
The front sub-assembly is completed by the screen frame and scuttle unit, which is welded to the top of the dash panel and wings. At its rear edge, the scuttle portion has a down-turned, U-section stiffening lip, immediately ahead of which are the twin outlets for heated air, for demisting. The cantrail is a welded-on top hat section, and the pillars are





Above left and right: The high torsional stiffness of the body structure of the car is derived largely from the rigid design of the dash portion and the boxing-in of the rear end by means of the seat squab and parcels shelf. Below, left: Each of the rear suspension dampers is attached to the top of the wheel arch, the inner valance of which is swaged to provide working clearance. The battery and spare wheel are recessed into the boot floor. Below, right: This view from beneath clearly shows the layout of the wing valances of the front sub-assembly. To the underside of the toe-board is welded the 16 s.w.g. cradle bracket to which is bolted the rack unit of the steering gear





of approximately channel section; they are subsequently boxed-in when the sides are added.

The lower edge of the toe-board is spot welded to form a lap joint with the leading edge of the floor sub-assembly, which incorporates the rear wheel arches, heel-board, side stowage boxes for oddments, seat pan, squab and boot floor. At each side, the main floor pressing slopes upward to form a shallow sill, terminating in a vertical flange with an outturned lip. Reinforcement of the floor is provided by a swaged longitudinal tunnel and a welded-on transverse member of 20 s.w.g. Within the tunnel, which is of semi-circular section with a radius of $3\frac{1}{4}$ in, are housed the hand-brake cables and the exhaust pipe. The cross member is attached to the upper side of the floor; it is of top hat section measuring $4\frac{1}{2}$ in wide × $3\frac{1}{2}$ in deep, and carries the seat anchorage brackets. To match the slope of the sills, its depth tapers at each end. Any tendency to resonance of the floor is reduced by a series of longitudinally disposed, indented swagings, and the stiffness of the tunnel is augmented by several transverse swagings of similar type.

The heel-board is flanged where it is welded to the rear edge of the floor. It is an 18 s.w.g. pressing and is reinforced near each side for the attachment of the leading end of the rear sub-frame. Gusset plates connect the ends of the heel-board to the wheel arches, which are just to the rear of it. Each wheel arch assembly consists of a dome-section arcuate portion and an inner valance panel, the two being spot welded together. In the valance is a vertical, channel-shape swaging that provides clearance round the suspension damper, which is attached to the top of the arch structure. The arcuate portions of the arches are of 20 s.w.g. steel, but 18 s.w.g. material is used for the more highly stressed valances, and the damper attachment points are reinforced by welded-on 16 s.w.g. brackets.

Each side stowage box forms a link between the wheel arch and the B pillar; it is welded to both of these and to the heel-board. The box is stiffened by a joggled top edge, and it is reinforced by a channel section member that runs from the base of the pillar to the heel-board and the wheel arch. This member is subsequently concealed by the

interior trim of the body. Between the transverse member on the floor and the front edge of each box is a pressing of L shape, the base of which is welded to the floor to form part of the inner face of the sill; the upright of the L constitutes a portion of the B pillar.

A single pressing comprises the seat pan and boot floor. It is flanged and welded to the wheel arches and the stowage boxes, and welded to the heel-board, which it overhangs at the front. Adequate rigidity is ensured by a lipped front edge, a channel-section support attached to the floor tunnel, a transverse step and various indentations. Two of these indentations are in the seat pan portion, and the others, which are of cupped form to carry the spare wheel and battery, are in the boot floor.

Much of the torsional stiffness at the rear of the body is derived from the squab panel. This is a slightly bowed pressing, which is flanged and welded to the seat pan, immediately ahead of its transverse step, and to the tops and sides of the wheel arches; it has a number of vertical flutes to reduce resonance. Its ends are also flanged, to increase the stiffness, but are attached only to the waist rail, not to the body sides. In the middle of the squab panel is a large hole in line with and similar to that in the dash panel, and serving the same purpose.

The rear ends of the wheel arches project below the boot floor. To these projections, and to the rear edge of the floor, is welded the domed, bottom rear pressing; a small quadrant-shape panel, which forms an extension of the inner valance of the wheel arch, converts each end of this rear pressing into a box. The externally flanged joint between the boot floor and the bottom panel serves as the attachment for the bumper. The boot floor is reinforced, for the sub-frame anchorage, at its junction with each wheel arch.

Each side unit of the body consists of a single main pressing, to which are added the various strengthening members. As already indicated, its joints to the front and floor sub-assemblies and to the rear panel are all of the externally flanged type. That to the roof is similar, but this, of course, is common practice.

At the A pillar, the leading edge of the door opening has a double-step section; the steps form the two faces for welding to flanges on the front sub-assembly. Above the waistline, this section comprises part of the screen pillar which, when the side is added, is of box section. On the lower portion of the pillar, however, the double step of the side and the folded edge of the wing valance together form an inward-facing channel: after the side is welded in position, a closing plate is added to this channel.

At its lower end, this closing plate is extended rearward as far as the cross member, to form the inner panel of the sill. It is welded to the floor and to the flanged edge of the upper face of the sill, the continuation of which to the B pillar is formed by the other L-shape pressing that extends forward from the stowage box of the rear sub-assembly. The B pillar itself is of box section for most of its depth, the box being formed partly in the main pressing and partly by a closing plate of Z section. Because of the convex profile of the body side, the transverse dimension of the box below the waistline is fairly large, so the longitudinal dimension is reduced in comparison with that of the upper portion.

As already indicated, the upper edges of the sides are lipped outward for attachment to the roof. Immediately below this lip is a longitudinal strip, the outer edge of which projects obliquely downward. The purpose of this strip, which was not embodied in earlier production bodies, is to deflect from the windows any water that spills from the gutters. Each cantrail consists of a top hat section similar to that used on the screen headrail portion of the front sub-assembly. This top-hat section stands on edge, and its lower flange is welded to the top of the side pressing, immediately below the lip just mentioned The upper flange of the cantrail—which in effect is continuous round the roof —is not welded to the roof, but forms a channel with it. The waist rail of the quarter light is another on-edge top hat section; its upper flange is welded to the flanged edge of the window opening but the lower one is not attached to the side. At its leading end, this rail is welded to the B pillar.

A single pressing is employed for the rear panel, which is pierced for the rear light, boot lid, and the fuel filler neck. The boot lid opening is peripherally swaged to form a drainage gutter; below it the panel is reinforced locally to take the lid hinges. On each side of the opening is a flat portion on which are mounted the rear lamp groups. The rear cantrail section is identical with that along the sides.

Since the parcels shelf is flanged and welded to the squab bulkhead, the rear panel and the sides, it makes the boot into a torsion box. In the shelf is a series of longitudinal, depressed flutes that increase its stiffness, and also two holes serving as sound outlets for the underslung speaker unit, if fitted, of a radio set. The lipped front edge of the shelf prevents any articles carried from falling on to the rear seat passengers under heavy braking.

There is sufficient bow on the roof panel to make internal stiffening unnecessary. The pressing has an upturned peripheral lip that seats on the corresponding lips on the sides, windscreen frame and rear panel. After the roof is put in position, the various lips are first tacked together by spot welds, and then the joint is completed

Right: Each door embodies a full-length stowage box of useful capacity; the frame of the door light is of channel section and enters the main structure, to which it is welded, by about 6 in. Far right: The petrol tank of the passenger-carrying vehicles is stowed at the left-hand side

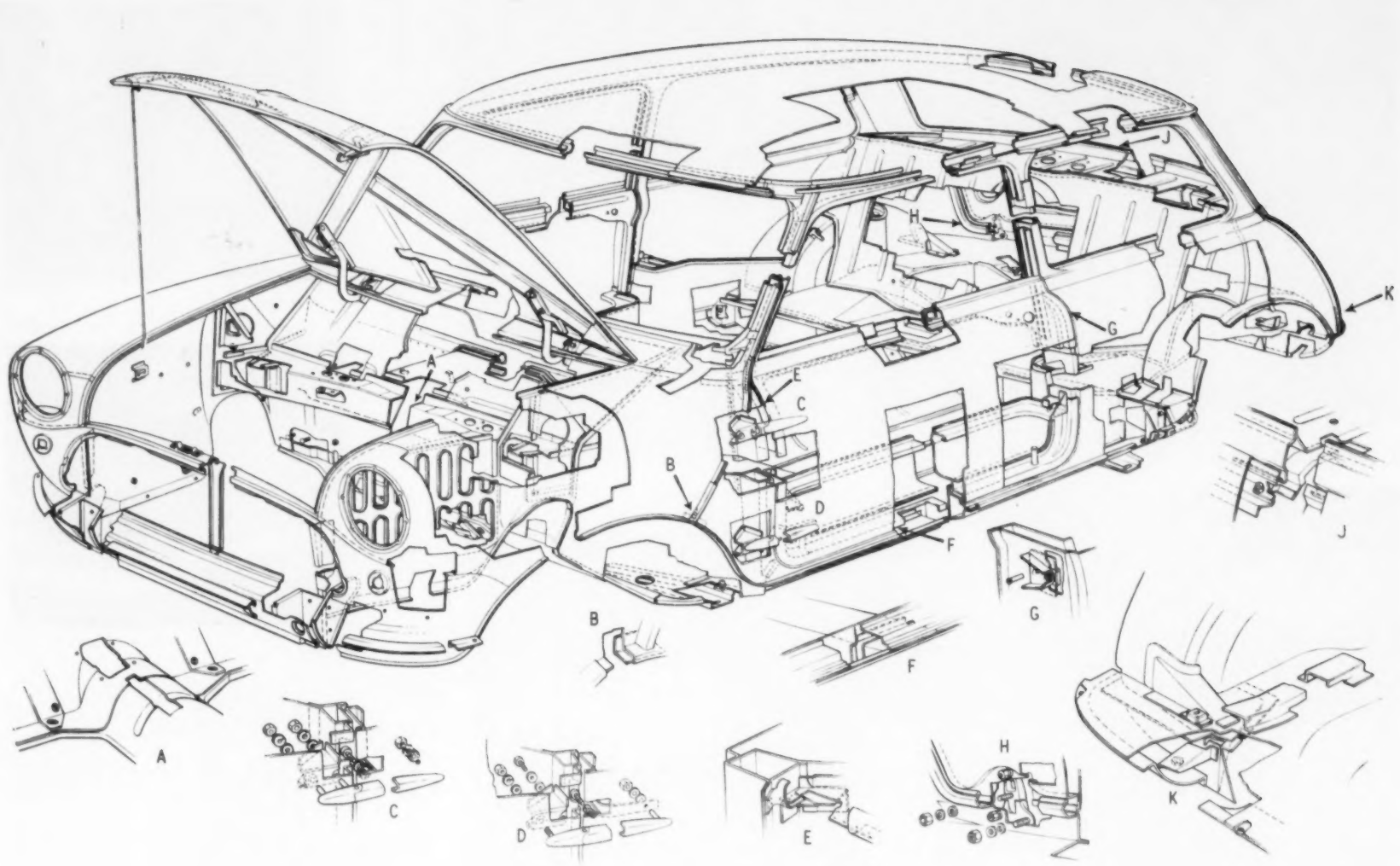
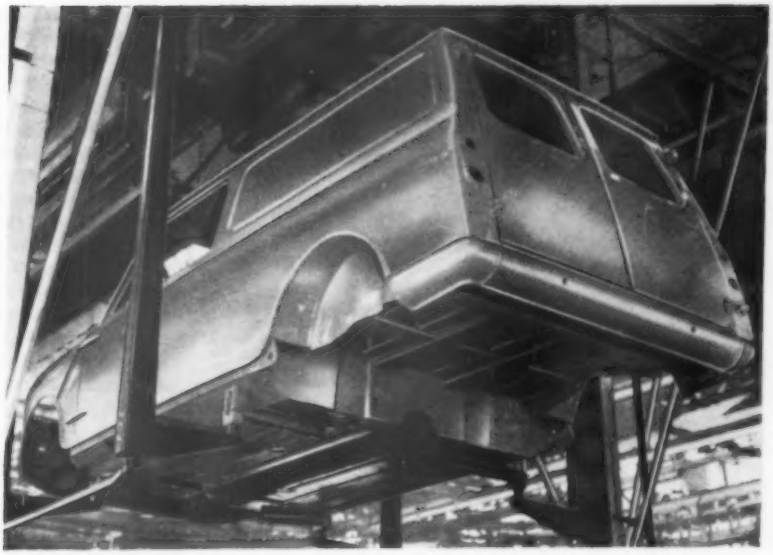


DIAGRAM SHOWING THE CONSTRUCTIONAL DETAILS OF THE ADO 15 SALOON BODY



The relatively deep heel-board and the longitudinal tunnel in the floor are both clearly visible in this underneath view of the van body. At the rear—ahead of the domed, bottom panel—is a transverse member, of inverted top hat section, that helps to support the load-carrying floor

by wheel welding. The gutter is initially relatively wide, to facilitate the wheel welding, but it is subsequently closed to a more aesthetically pleasing width by a rolling process, in which a length of steel rod is inserted in the gutter as a former. Four drain holes are pierced in the gutter, one near each corner of the roof, during the pressing operations on the panel.

The outstanding feature of the doors is the fact that each embodies a full-length stowage box of useful width and depth. This construction is made possible by the use of sliding windows instead of the winding type, and the construction of the boxes is such that they impart torsional stiffness to the doors. A stiffener of Z section is spot welded to the upper edge of each box, which in turn is welded to the lower part of the single pressing comprising the frame of the door. The sides and bottom of the frame have a Z section with a lip on one flange; the unlipped flanges are on the periphery and are pinched by the folded-over edges of the outer panel.

Along the top of the door panel, the frame is of L section, which is connected to the outer panel by a channel pressing: one flange of the channel is welded to the frame and the other is pinched by the outer panel. Above the main part of the door is the frame for the glass. It is of channel section, and, for rigidity, each end of it enters the door structure, to which it is spot welded, by about 6 in. External hinges of streamlined shape are employed, and both the door and the A pillar are locally reinforced at the attachment points. The methods of reinforcement are shown in detail in the reproduced body construction diagram.

Because of the need for minimal overall length of the vehicle, the boot is relatively small, so its effective carrying capacity has been increased by the use of a bottom-hinged lid, supported by stay cables. This lid is therefore of more rigid construction than would be one hinged at the top. The domed outer panel of the lid has a flat indentation to which the number plate is attached. It is peripherally pinched on to the inner, reinforcing pressing, which consists of a hollow rectangle and two triangulating members that extend from the bottom corners of the rectangle to its upper side. This pressing is of top hat section, and each triangulating member is attached to the indented portion of the outer panel by five spot welds.

The bonnet lid has lipped edges and is stiffened by a cruciform structure consisting of two pressings of top hat section. Only the ends of these members are attached to the panel, but not directly: they are welded to joggled triangular brackets, which themselves are welded to the lid. Felt strips are inserted between the members and the panel. Both members are continuous, the cross-over being effected by a local reduction in the section depth of each; the two are spot welded together at the junction. Each of the brackets carrying the hinge arms are welded to one of the members and to the rear lip of the panel. Alongside the right-hand bracket is the retaining clip for the support stay, which is attached to the leading edge of the bonnet.

Estate car and van bodies

The front sub-assemblies of these two largely similar bodies are identical with that of the car, with one exception in the case of the van. This exception concerns the radiator grille, which is integral with the front panel, instead of being a separate component. Most of the rear sub-assembly is common to both the estate car and the van, as are the roof, rear doors and basic side pressings, though the van sides are not, of course, pierced for windows. The side doors are identical on all three vehicles.

A fundamental difference between the other two bodies and that of the car is in their wheelbase which, as was stated earlier, is 4 in longer. The increase has been obtained merely by lap welding a transverse pressing of that effective width to the rear of the main floor panel, and welding the heel-board to the rear of the additional pressing. A further major change results from the fact that neither of the longer bodies has a fixed rear squab panel, while both have large rear door apertures, and so a separate rear frame is necessary to ensure adequate torsional stiffness. This frame consists of a 16 s.w.g. hoop of channel section, on which the rear doors are hung.

Whereas the sides of the car each consist basically of a single pressing, each side of the other two bodies is in two portions welded together. The front portion includes part of the A pillar, the B pillar, and the sill and cantrail between these pillars; to the B pillar is welded the main side panel, which runs round the quarters to join the rear frame. A transverse member of inverted top hat section bridges the upper ends of the B pillar and is separated from the roof panel by a layer of felt. The roof has rather more bow than

In the van body, each side is reinforced by a vertical member of top hat section. The tops of the B pillars are bridged by another top hat member, and the rear doors are hung on a channel section frame

that of the car, because of its greater length. There is no cantrail behind the B pillar.

In the case of the van, each main side panel is stiffened by the swaged waistline, by a rectangular channel-section indentation—corresponding to the long quarter light of the estate car—and by a vertical member of rounded top hat section. This member has closed ends and extends from just below the roof to about 6 in above the load-carrying platform. It is attached to the side panel only at its ends; a strip of foam rubber separates it from the panel over most of its length. On the estate car, the counterparts of these members are waist-high webs, welded to the sides and the floor, which also serve as supports for the squab of the rear seat.

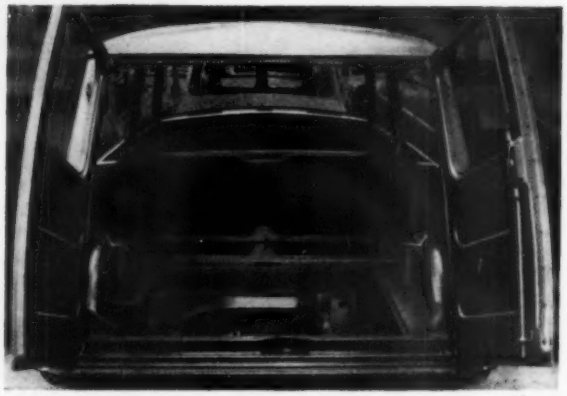
Because the load-carrying platform of the van is part of the permanent structure, the stowage of the spare wheel and battery has been transferred from the rear, as in the car, to the main floor ahead of the heel-board, the depth of which is increased. The platform is well supported. It is welded to the top of the heel-board, to the wheel arches and to the rear frame; its leading edge, which is in line with the B pillars, is stiffened by a box member fabricated from two angle section pressings, and is carried on a bracket at each side and another in the middle.

Behind the heel-board, the platform is reinforced by three inverted top hat members, one transverse and the others longitudinal, welded to its underside. In addition, it sits on a transverse member, also of inverted top hat section, which bridges the lower rear portions of the wheel arches and to which the sub-frame is attached. Finally, the inverted domed bottom panel, below the rear doors, is boxed in by a valance pressing between its lower edge and the underside of the platform.

On the estate car, the side stowage boxes are retained, and their rear ends are welded to the webs ahead of the wheel arches, instead of directly to the arches. To carry the front edge of the rear seat cushion — in its normal, unstowed position—a transverse inverted-channel member is mounted between the boxes, to which it is welded. Sagging of this member is prevented by a medial support bracket between it and the tunnel portion of the main floor; both ends of the bracket are attached by welding.

The rear end has certain points in common with both the car and the van: although the heel-board is the same height as that of the car, and the rear floor incorporates similar stowages for the battery and spare wheel, this floor has a greater length, similar to that of the van, and is welded at its rear edge to the frame hoop. Another point of similarity with the van is the boxing-in of the bottom rear panel. Because of the presence of the rear seat, the carrying platform of the estate car is substantially shorter than that of the van; since there has to be a means of access to the stowages just mentioned, only the surround is part of the permanent structure. This surround consists of side panels, welded to the wheel arches and supported by brackets from the rear floor, and of front and rear rails. The front rail is at the top of an extension of the heel-board projecting above the rear floor, and that at the back is attached to the base of the frame hoop. A $\frac{1}{2}$ in thick plywood panel fits into this surround, which has Z section edges, to form a seating. The panel is normally covered by carpeting.

Following tradition, the ADO 15 estate car has wooden framing on the body sides, quarters and rear doors. The timber employed is ash and the sections are cemented together and attached by screws. Although it is a matter of opinion whether this framing enhances the appearance of the body, it must add to the cost without contributing significantly to the structural strength.



A plywood panel normally covers the spare wheel and battery stowage of the estate car; the surround is part of the permanent structure

On both the saloon and the estate car, the fuel tank is installed on the left side behind the rear wheel arch. However, the differences in body form have necessitated different tank shapes and capacities—$5\frac{1}{2}$ gal for the car and $5\frac{3}{4}$ gal for the other vehicle. In the case of the van, to avoid obstruction, the tank is stowed under the right-hand rear corner of the load-carrying platform; its capacity is 6 gal.

Finally, it is worthy of mention that considerable efforts have been made to minimize the use of lead for filling purposes on the bodies. Filling of this type is, of course, expensive in terms both of material and labour, since skilled men are necessary to execute it. Except where a surface blemish is revealed on inspection, filling is only necessary on the roof gutter, above the inclined flange joints at the windscreen and quarter pillars.

Electrical equipment

A conventional 12 V d.c. electrical system, with positive earth, has been adopted for the ADO 15 vehicles. With the exception of the sparking plugs, which are of the Champion N5 type, all the standard equipment is of Lucas manufacture. The current is supplied by a type C40 generator,

which is situated ahead of the cylinder block. It is belt driven from the crankshaft—at 1·61 times engine speed—in the conventional manner, and has a maximum output of 22 A at 2,200 r.p.m. A type RB.106/2 current-voltage regulator, mounted on the front of the dash, controls the generator output. The SLTW7A battery has a capacity of 34 A-hr at the 20 hr discharge rate; its stowage has already been described.

Relative to the cylinder block, the distributor occupies the same position as it does on the Austin-Healey Sprite, described in the July and August 1960 issues of *Automobile Engineer;* it therefore projects obliquely forward from the front of the block, high enough to be reasonably accessible when the bonnet is raised. It has the type designation DM2 and affords the conventional combined vacuum and centrifugal automatic control of the ignition timing. To minimize the length of the high-tension lead to the distributor, the LA12 coil is mounted on the top of the clutch bell housing.

The type M35G/1 starter lies behind the crankcase; it has a maximum input of 340A. On its pinion are 9 teeth, and there are 107 teeth on the flywheel ring. The starter switch is a push-button mounted on the floor immediately ahead of the driver's seat.

Because of the relatively small frontal surface available for the installation of lamps, the 6 W sidelamp bulbs are embodied in the F700 headlamp units, which are conventionally mounted at the front of the wings. The headlamp bulbs have 50/40 W filaments. At the front, the amber flashing type turn indicators are separate, situated below the headlamp units, but those at the rear are grouped with the rear lamps and reflectors. The lights are controlled by a three-position toggle-action switch, housed on a panel in the middle of the parcel tray, and by a foot-operated dip-switch.

Twin-blade, self-parking windscreen wipers are installed, driven by a type DR2 motor mounted on the dash, and controlled by a second toggle-action switch on the panel. In the speedometer are incorporated warning lights for the ignition, oil pressure and headlamp main beam, whereas that for the turn indicators is embodied in the switch lever on the steering column. On the standard saloon and the van, the only interior light is that provided from two windows in the speedometer nacelle. The de luxe saloon has the addition of two courtesy lights, one on each side of the rear seat, and the estate car has a roof lamp. These courtesy lights are controlled by their own switches, not by the more usual door-operated type.

On all three versions of the ADO 15 a Smiths 2½ kW recirculatory heater is available as an optional extra. It is installed centrally, immediately under the front parcel tray. Another extra is a Smiths Radiomobile radio set; the receiver of this is mounted alongside the heater, on the passenger's side, and the speaker unit is attached to the underside of the parcel shelf behind the rear seat.

Morris Prime Mover

Recently Introduced Tractor Unit Designed for a Gross Train Weight of 18 Ton

AT the recent Morris Commercial Vehicle show, in which about 170 different vehicles were featured, a new prime mover was introduced. It is powered by a B.M.C. six-cylinder engine having a bore and stroke of 100 and 120 mm, and a swept volume of 5,655 cm³. This engine, which is a development of the earlier 5·1 litre direct injection diesel unit, is claimed to have a power output of 105 b.h.p. at 2,400 r.p.m. and a maximum torque of 255 lb-ft at 1,750 r.p.m. Its compression ratio is 17·7 : 1.

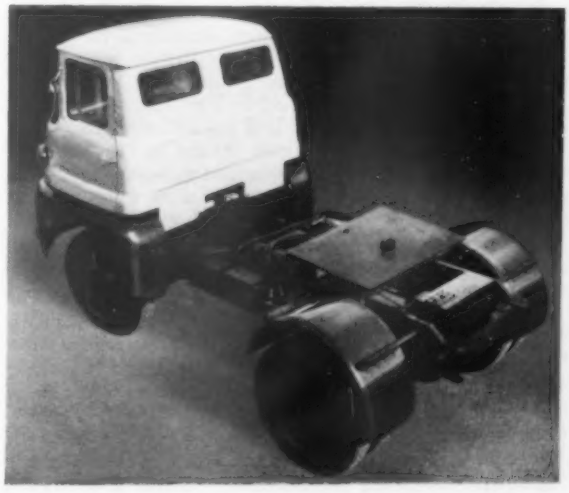
The transmission assembly comprises a Borg and Beck 13 in diameter single-dry-plate clutch used in conjunction with an E.N.V. five-speed gearbox having constant mesh gears for the third, fourth and top ratios. This gearbox gives the following ratios: first, 7·582 : 1; second, 4·381 : 1; third 2·396 : 1; fourth, 1·478 : 1; fifth, 1 : 1; reverse, 7·510 : 1. A Hardy Spicer 1510 propeller shaft transmits the drive to an Eaton two-speed 16,500 type rear axle, giving ratios of 6·14 : 1 and 8·54 : 1. There is no alternative single-speed axle.

In other respects, the layout is conventional. Cam Gears EQ type steering gear, with a ratio of 23·5 : 1, is employed, and the steering wheel is 20 in diameter. At both the front and the rear, semi-elliptic springs are fitted. Their dimensions are as follows: front, 45 in between eye centres, leaf width 2½ in; rear, 51 in between eye centres, leaf width 2½ in. Helper springs are installed at the front, as standard, and are optional at the rear. Steel disc wheels carry 8·25—20, 14-ply tyres or, as an option, 9·00—20 12-ply tyres, and an 8-stud fixing arrangement has been adopted.

The principal dimensions are: wheelbase, 8 ft; track, front, 5 ft 10¼ in; rear, 5 ft 8½ in; overall length, without trailer attachments, 14 ft 4⅞ in; overall width, over front wings, 7 ft 5 in; and overall height, laden, 7 ft 11⅛ in. The height in the laden condition, as measured between the frame and the ground, is 2 ft 9⅛ in, and the turning circle is approximately 35 ft diameter. It is estimated that the kerb weight of the vehicle without the coupling gear is 3 ton 1 cwt.

Girling hydraulic brakes of the two-leading-shoe type are employed. On the front axle, the drums are 16 in diameter and at the rear they are 15¼ in diameter. The total friction area is 480 in². A mechanically operated handbrake control, of course, operates on the rear wheels, and the footbrake system includes a vacuum servo. The pressed steel channel section frame has four cross members, and the dimensions of the side members are 9⅛ in deep × 3 in wide × ¼ in thick.

The Morris forward-control prime mover has a 5,655 cm³ diesel engine

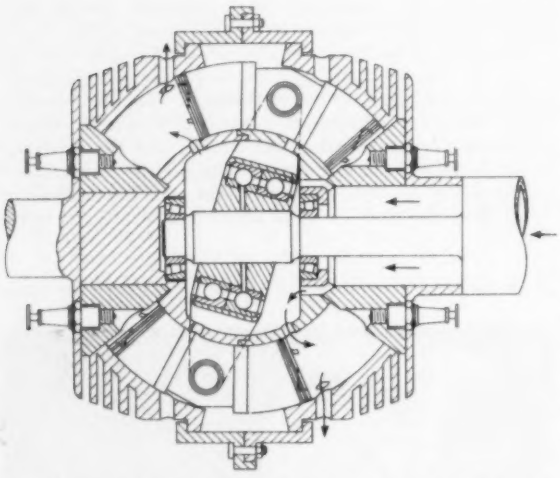


Selwood Orbital Engine

A Prototype 12-Cylinder Two-Stroke Rotary Power Unit of Unusually Compact Design

SINCE progressive designers have always been dissatisfied with the orthodox reciprocating piston engine, owing to its fundamental shortcomings, their attention has inevitably been directed towards power units in which all motion is rotary. The fact that no such engine has yet become a commercial success in the automotive field is an indication of the magnitude of the problems associated with it. Gas turbines, for all their remarkable progress in aircraft and industrial applications, remain, in the opinion of many, a basically unsuitable unit for the smaller types of car. That promising newcomer, the N.S.U-Wankel engine—described in the May 1960 issue of *Automobile Engineer*—is now said to be approaching the production stage, but quite a lot of development work remains to be done.

In this context, the announcement early in May of the prototype Selwood orbital engine, as it is called, aroused considerable interest. This 12-cylinder two-stroke power unit, which has been built by William R. Selwood Ltd, of Chandler's Ford, Southampton, is of ingenious design, and its first public demonstration was attended by a large number of engineers representing automotive, agricultural, aircraft and industrial interests. Because of Selwood's limited manufacturing facilities, only one engine has so far been built; at the time of writing, it had been run for over 300 hours, under various conditions of load, and no replacements of any kind—not even sparking plugs—had been required. The chief advantages claimed for the design are exceptionally good balance, very smooth torque characteristics, low mechanical stresses and friction losses, and unusually compact dimensions and low weight in relation to the swept volume.



This diagrammatic view of the Selwood orbital engine, as seen in longitudinal section, shows the part-toroidal form of the cylinders and the inclination of the axis of the spider on which the pistons are carried. The arrows indicate the gas flow through the engine

In effect, the basis of the Selwood engine is a kinematic inversion of the swash-plate system, which, of course, is now commonly employed in hydraulic pumps and motors. Consequently, the cylinders and piston assembly revolve round a stationary shaft; the output shaft forms an extension of the cylinder casing. Although, obviously, the pistons must reciprocate within their cylinders, this reciprocation is only relative, not actual—because they simply orbit about an axis set at an angle relative to the axis of rotation of the cylinder block—so the high inertia forces of the conventional engine are avoided. The absence of connecting rods —and their attendant side thrust of the pistons on the cylinder walls — makes the primary contribution to the low frictional h.p. of the unit.

Once the principle of operation is understood, the mechanical design of the engine follows logically. To impart the desired orbital motion to the pistons, they are mounted on a spider assembly, the axis of which is inclined at an angle to that of the stationary shaft, as mentioned in the previous paragraph; the point of intersection of these two axes is at the geometric centre of the unit. In describing their circular orbit, the pistons therefore execute harmonic reciprocatory motion in relation to the cylinders.

It will be apparent that the stroke of the pistons is a function of the angle of inclination of their orbital plane. Because the perpendicular distance from the orbit to the shaft axis decreases progressively from the mid-stroke position towards the extremes of the stroke, the cylinders are part-toroids, the axis of each being on a plane also containing the shaft axis. The intersection point of the axes of the shaft and the spider is, of course, the centre from which the arcuate axes of the part-toroids are struck.

In the prototype engine, the twelve cylinders have a bore of $1\frac{1}{4}$ in and are arranged in two circular banks of six, with the spider between them: the cylinders of each bank are equally spaced round the shaft, and their axes are continuations of those of their counterparts in the other bank. It was originally intended that the two cylinder blocks should be stainless steel forgings, but so long a delivery period was quoted that, to speed up the construction, it was decided to machine these components from solid mild steel. Coaxiality of the two is ensured by spigoting them together; the spigot, which is within the circle of cylinders, is not continuous because of the need for working clearance over the arms of the spider. Dowels provide circumferential location. Cooling fins are machined round the cylinder blocks, which are secured together by a clamping ring of the split type. This ring is omitted in the accompanying half-tone illustration, to reveal some of the working parts.

The combustion chambers are embodied in the two aluminium cylinder heads, each of which has the form of a truncated cone and seats in a corresponding conical recess in the blocks. A ring of six socket-head bolts secures each cylinder head, into which the sparking plugs are screwed axially. It has been found that the face areas of the joint are sufficient to ensure gas tightness without the use of gaskets or any other means of sealing.

Two taper roller bearings, one housed in each cylinder block, carry the rotating block assembly on the stationary shaft, which extends through a bore in one of the cylinder head units. At the other end of the engine unit is the output shaft, which is flanged and bolted to the block. The engine is mounted, very simply, by means of an external support for the stationary shaft and a housing for a heavy-

duty ball bearing on the output shaft. Because diagonally opposite cylinders fire simultaneously, no provision has to be made to resist heavy end thrust, though the arrangement does result in a rocking couple.

On the stationary shaft, mid-way between the taper roller bearings, is mounted a fixed sleeve, the periphery of which is machined in such a way that its axis is inclined 11½ deg relative to that of its bore: this, of course, is the orbit angle of the spider. Pressed on to the sleeve are the inner races of the spider bearings, which are of the angular-contact ball type, mounted in opposition. The outer races are pressed into the bore of the spider which, in this instance, is machined from 45 ton steel bar. In production, a steel forging would, of course, be used.

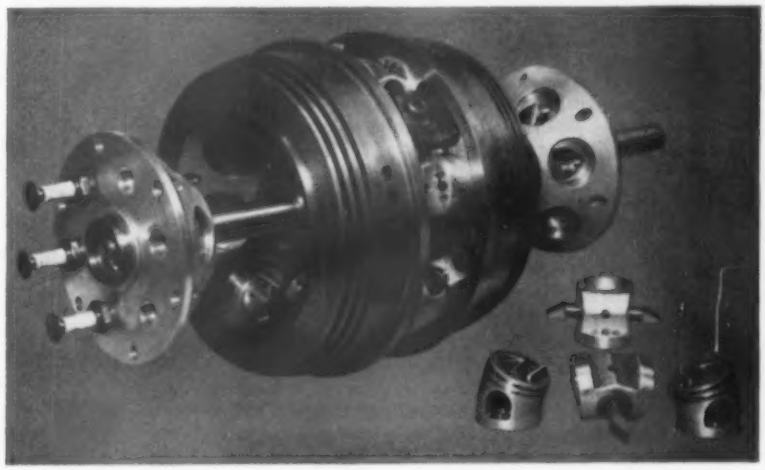
The tips of the spider arms are bridged by six members equivalent to gudgeon pins, each of which consists of a steel rod with wedge-shape ends. On the rod, mid-way between its ends, is an integral spherical portion that forms part of the ball-joint mounting of the piston. The adjacent ends of each pair of gudgeon pins are located on and clamped to the tip of the appropriate arm by a cap secured by a socket-head bolt; by virtue of the use of wedge ends to the gudgeon pins, no angular machining of the caps is necessary.

Manufacture of the six double-ended pistons is simplified by making each in three parts: the two identical end portions, which carry the rings, are spigoted and bolted to the intermediate portion containing the ball joint. The piston material is RR59 light alloy, chosen because of its combination of good bearing properties and high strength at elevated temperatures; each piston assembly weighs about ½ lb. It will be appreciated that the distance between adjacent pistons, measured along their orbital path, varies continuously round that orbit. This variation is accommodated by allowing four of the ball-joint sleeves to float axially in the pistons. The other two sleeves, those of a pair of pistons situated mutually at 180 deg on the spider assembly, are fixed in their housings, to provide basic circumferential location between the spider and the casing. Measured along the curved cylinder axis, the full stroke of the pistons is 1½ in.

Following normal two-stroke practice, the piston rings are pegged, to prevent their ends from catching in the ports and, for this application, to ensure that they bed properly to the curved bores. In theory, of course, the rings should be of part-toroidal form, but it was felt that, if they were narrow, this complication was unnecessary in view of the very small curvature involved. Consequently, standard rings are employed, and have proved entirely satisfactory. As will be seen from one of the illustrations, deflectors have been added to the pistons, to improve the gas control.

Induction and exhaust arrangements

Because the volume of the spider chamber is constant, a Wade blower is used to provide the small positive induction pressure necessary for effective scavenging. The blower is belt driven from the output shaft, the drive having a speed-up ratio of 3½:1. Higher induction pressures are to be tried in the near future: for this reason, the compression ratio is only 3:1. The engine is run on a 16:1 petroil mixture, the proportion of oil having been deliberately set higher than was thought necessary, to avoid any possibility of under-lubrication. Examination of the moving parts after a run indicated that it should be practicable to reduce the oil supply by up to 50 per cent.



The prototype Selwood power unit partially dismantled. Each piston consists of three components, and is mounted, by a ball-joint, on a gudgeon pin clamped at its ends to the tips of adjacent arms of the spider. Six sparking plugs are screwed axially into each of the aluminium cylinder heads, which have conical seatings in the blocks

The blower draws mixture from an S.U. horizontal carburettor with a 1 in diameter throttle barrel. From the blower, a pipe leads to the exposed end of the stationary shaft, which is hollow and of larger diameter than the solid portion that is within the engine. The diameter is reduced at a shoulder, adjacent to the outer end-face of the cylinder head; there is a running seal between the shoulder and a spigot extending from the head. Ports in the shoulder enable the gas to pass from the hollow part of the shaft to the annular space between the solid portion and the bore of the head. From this space the mixture enters the spider chamber through ports in the end wall of the cylinder block.

Both the inlet and the exhaust ports in the cylinders are of the conventional, piston controlled type: the inlet ports, of course, communicate with the spider chamber, and the exhaust ports are in the periphery of the casing. Although the gas flow is thus assisted by centrifugal force, the effect is likely to be appreciable only at relatively high engine speeds. So far, no development work has been done on the size, shape and timing of the ports, factors that of course profoundly affect the performance of two-stroke engines.

At present, the exhaust ports discharge directly into the atmosphere, a separate extractor fan and ducting being used to remove the gases from the test shop. However, an ingenious exhaust system has been evolved and will shortly be fitted. This consists of a static collector ring, with seals bearing lightly on the casing, an extractor fan revolving with the casing, and a masking or control member. The

last-mentioned member does not revolve but can be rotated through a small angle round the casing, over which, in prototype form, it has a clearance of 0·010 in. Its function is to mask the exhaust ports beyond the point at which they are uncovered by the piston. Since the angular delay can be varied at will, the use of basic timing that is suitable for high-speed conditions need not result in excessive mixture loss into the exhaust system at low speeds. With fixed port timing and high boost pressures, this loss would be severe.

Ignition system

Because the complete engine rotates, it has been possible to dispense with the conventional distributor. The six-lobe cam of a twin contact-breaker unit is driven through 1 : 1 gearing from the output shaft; each half of the unit serves its own 12 V coil and one set of six sparking plugs. From each coil the high-tension lead is taken to an electrode carried in an insulated block, mounted on one of the engine bearers, adjacent to the cylinder head. The usual terminal nuts of the plugs are replaced by mushroom-shape caps.

As the engine revolves, these caps pass successively over the face of the electrode, as the contact-breaker points open, and so pick up the current. There is a small clearance between the caps and the electrode; in terms of the performance of the ignition system, this clearance is not critical over quite a wide range, but it is set at about 0·015 in. Owing to the large surface areas involved, there were no appreciable signs of erosion after the 300 hours' running.

Technical appraisal

From the design viewpoint, the Selwood engine is undoubtedly very interesting, but it is by no means easy at the present stage of development to assess its practical possibilities as a prime mover. On the credit side is the appeal of compact dimensions and good balance. The prototype is only about 10½ in diameter and 9 in long over the casing, and its present swept volume of 715 cm³ could, according to Selwood, be increased to 1,000 or even 1,100 cm³ without enlarging the casing. Without the blower, the unit weighs 60 lb, and it is estimated that, with a free choice of materials, this figure could be brought down to about 45 lb. It follows that, if the engine can produce about 30 b.h.p/litre—a modest figure for a modern automotive engine—a power : weight ratio substantially better than 0·5 b.h.p/lb could be achieved.

Up to the present, however, no power or torque figures have been divulged, so it is not possible to judge whether the output quoted is within the unit's capabilities. It would be surprising, however, if a net output anywhere near that level has yet been obtained: not only has the blower to overcome the resistance of a decidedly long and tortuous induction tract, but the compression ratio—as has already been stated—is very low, and the engine has not so far been run at over 3,500 r.p.m. though designed for a maximum of 10,000 r.p.m. These remarks apply, of course, to the prototype layout: the manufacturers state that, for the production version of the engine, they are developing a much improved induction system, in which the distance between the carburettor and the power unit is reduced, the inlet tract straightened and the Roots type blower obviated.

The engine is certainly very well balanced, because of the symmetrical arrangement and the elimination of the normal primary and secondary reciprocating inertia forces; to judge by the smooth running of the prototype, the rocking couple caused by the diagonally opposed explosions is not of a significant magnitude. Nevertheless, because of the advances made in engine mounting technology, near-perfect balance is no longer a major design objective in the case of an automotive engine, though it is desirable in, for example, an application where a portable type of power unit is needed.

If the claim for low friction losses is to be substantiated, it is obviously necessary for the pistons to be held clear of the bores, in a radial plane, under all conditions of operation. Any radial thrust in the region of the hot exhaust ports would, of course, be particularly undesirable. The maintenance of the correct operating clearance is dependent on both mechanical and thermal considerations. At high speeds, the centrifugal force acting on the piston assemblies could be sufficient to apply a large bending moment to the gudgeon pins and to cause them to deflect. However, the designers state that their calculations show that, in fact, there will be no serious difficulties in this respect.

In addition, the thermal expansion rates of the cylinder casing and the spider will not necessarily balance each other, and any discrepancy here will be an addition to the differential expansion between the bores and the pistons. There is also the likelihood of some departure of the bores from the true part-toroidal form, owing to the non-uniform heating of the casing. In spite of the absence of connecting rods, each firing impulse must impart some side thrust on the piston in order to cause the engine to revolve. It is therefore noteworthy that, over the range of speeds and loads so far investigated, orthodox piston clearances in the radial plane from the shaft axis have been found satisfactory, so there has been no appreciable slap, due to the side thrust, and hence no need of oval-turning the pistons.

This situation may well change, however, when serious attempts are made to increase the power output. The first step in this direction will probably be to raise the boost pressure, and this will in turn raise the temperature of the exhaust ports, thereby increasing the tendency towards unbalanced expansion. Only by prolonged bench testing, under a wide variety of conditions, will it be possible to determine whether the thermal problems can be solved.

Engineers who have studied the swash-plate type of power unit will be aware that, in general, it gives a lower mechanical efficiency than does the conventional layout. This is, of course, due to the fact that only a small component of the piston thrust can apply an actual turning moment; the rest of the thrust merely produces end loading in the system. The useful component is proportional to the cosine of the angle between the direction of thrust and that of rotation of the driven member. Since in the prototype Selwood engine this angle has a maximum value of 78½ deg, the efficiency with which piston thrust is converted into torque is likely to be lower than that provided by the equivalent engine of conventional layout. If the pistons do operate under their designed conditions of clearance, this disadvantage should be partially offset by the reduced friction.

It is understood that, when more work has been done on evaluating the present two-stroke version, a four-stroke unit will be evolved. Use of the four-stroke cycle would, of course, make a supercharger unnecessary, and it should raise the thermal efficiency, but there might be difficulty in getting the mixture into the cylinders at the output end of the engine. The valves would presumably be actuated by cam rings driven at the appropriate speed.

There can be no doubt that it is more expensive to machine the bores of cylinders with part-toroidal than with straight axes. Nevertheless, modern methods make them entirely feasible, and the same can be said of the pistons. In other respects, it would appear that, in its present form, the engine should be straightforward and relatively inexpensive to manufacture. It is almost axiomatic, however, that the severity of the development problems increases with the degree of unorthodoxy of a design. Consequently, the next stages of intensive development work are likely to be more than usually critical in determining the ultimate success or failure of this remarkable and unconventional power unit.

Citroën Ami 6

New Small Car, with a 22 b.h.p. Power Unit, Introduced by a Famous French Company

An unusual feature of the Ami 6 is the use of rectangular headlamps

FOR some time it has been known that the French Citroën company was developing a new small car that would have a livelier performance and greater accommodation than the remarkable but now rather antiquated 2CV model. The newcomer, which is designated Ami 6, was actually announced at the end of April, too late for reference to be made to it in our May issue. It has a 602 cm^3 horizontally opposed, air cooled twin-cylinder engine driving the front wheels, a suspension system of the inter-acting type similar to that of the 2CV, and a handsome and spacious four-door, four-seat saloon body. In common with other Citroën models, the car has an unusually long wheelbase, for this class of car, a feature that no doubt contributes to the good riding qualities claimed by the makers.

The engine has cylinder dimensions of 74 × 70 mm and bears a marked resemblance to the 2CV unit. Its features include aluminium cylinder heads with part-spherical combustion chambers and pushrod operated valves. To permit the use of one-piece connecting rods the crankshaft is of the built-up type, the crankpins being a shrink fit in the webs. The compression ratio is 7·4 : 1, as against the 7·0 : 1 of the 2CV engine. Cooling air is supplied by a crankshaft-mounted fan, which is a nylon moulding and has eight blades; pressed steel ducting distributes the air to the cylinder barrels and heads. A Solex 30PB1 carburettor feeds into an exhaust heated riser, from which two induction pipes lead to the cylinder heads.

Whereas the inlet passages of the 2CV unit were of small diameter to restrict the engine speed for maximum power to 3,800 r.p.m, the new unit has been designed to breathe more freely, with the result that the peak of its power curve occurs at 5,000 r.p.m. The maximum gross b.h.p. of 22 is 83 per cent greater than that of the 2CV, though the swept volume is only 42 per cent larger. A maximum torque of 29·6 lb-ft at 2,800 r.p.m. is quoted; since the corresponding value for the smaller engine is 17·4 lb-ft at 2,500 r.p.m, the increase is 70 per cent—a really worthwhile amount.

The maximum b.m.e.p. of the new engine is 121 lb/in^2. Though this is only a moderate figure, it is 20 per cent higher than the 101 lb/in^2 given by the 2CV power unit. An indication of the relative abilities of the two engines to sustain a high cruising speed in adverse conditions of wind or gradient is given by comparing the torques at maximum power: these are 23·1 and 16·6 lb-ft respectively, so the margin in favour of the larger model is 39 per cent.

In general, the layout of the transmission follows that of the earlier vehicle, the main difference being that the all-indirect four-speed gearbox has synchromesh on all forward gears instead of on the upper three only. The gearbox ratios are: fourth, 1·32 : 1; third, 1·92 : 1; second, 2·90 : 1; first and reverse, 5·62 : 1. By the use of a double cardan type of universal joint at each end of each drive shaft to the front wheels, a constant velocity characteristic is obtained. Unsprung weight is reduced by mounting the front brakes inboard of the drive shafts; the drums are transversely finned for cooling.

A detailed description of the inter-acting suspension system and its inertia type dampers is hardly necessary, because these have been fully covered by previous articles in *Automobile Engineer*—in the July 1953, May 1954 and January 1957 issues. It is sufficient to mention here that each wheel is carried on a tubular arm—leading in the case of the front wheels and trailing at the rear—and that the two arms on each side are connected by tension rods to a common spring unit floating on its mounting under the floor. By means of this arrangement, the vertical movement of one wheel is resisted by the other on the same side. In addition to the inertia damping unit at each wheel, there are friction dampers at the pivots of the arms. The wheels are fitted with 125 × 380 mm Michelin X tyres.

As in the case of the Citroën ID and DS cars, there is a rigid platform type of chassis. For ease of repair, the body is built up from a number of separate and unstressed sub-assemblies. A departure from the company's previous practice in body construction is marked by the use of plastics material for the relatively flat roof panel; this material should give better thermal insulation than a steel panel, as well as being lighter.

Though the body styling is decidedly modern, it has the individuality that has come to be expected of Citroën vehicles. The rear light is flat and has a rearward rake—reminiscent of the Ford Anglia layout—and the leaning-back motif is extended to the B pillars, which have a pronounced rake from just below the waistline; consequently, the wide doors are basically of lozenge shape rather than rectangular. By virtue of shallow door sills, entering and leaving the vehicle are easy, and there is adequate head and leg room; both the front and rear seats are of the bench type. Ample luggage accommodation has been obtained by stowing the spare wheel in the engine compartment; presumably the company is satisfied that the adverse effect of relatively high temperatures and an oily atmosphere on the life of the tyre is not significant.

Another styling characteristic of the car is the use of rectangular headlamps, made specially by the Cibié company. These lamps have what is described as a triple reflector system, which is claimed to provide a beam of good intensity and depth, equivalent to that produced by conventional lamps of a size that would be difficult to house on a small car. As in the 2CV model, the driver can adjust the headlamp beam setting by means of a mechanical linkage. Included in the equipment of the Ami 6 is a heater installation, with provision for demisting and de-icing.

The major dimensions of the car are as follows: wheelbase, 7 ft 10¼ in; front track 4 ft 1⅜ in; rear track 4 ft 0 in; overall length, 12 ft 8 1/16 in; overall width, 4 ft 11⅞ in; overall height, 4 ft 10½ in; ground clearance, 6 in; turning circle, 36 ft; dry weight, approximately 12 cwt. A maximum speed in the region of 65 m.p.h. and a fuel consumption in the region of 43 to 51 m.p.g. are quoted by the manufacturers.

NEW BRITISH CAR

Summary of the Noteworthy Features of a Recently Introduced Vehicle

FORD CONSUL CLASSIC 315

WHEN the current Ford Anglia car was introduced in 1959, there was considerable speculation as to the reason for the adoption of a stroke : bore ratio as low as 0·598 : 1 in the 997 cm³ power unit. Since it is generally agreed that, in the case of a car engine of normal type, other factors have a greater influence than the stroke : bore ratio on the characteristics, it seemed likely that the object was to permit a subsequent increase of the swept volume by lengthening the stroke. This assessment has been proved correct by the introduction last month of the Consul Classic 315 saloon, which has a 1,340 cm³ engine, based on the smaller unit and having a number of common components, including the cylinder block casting.

In essence, the Classic 315 — otherwise known as the Ford model 109E—is a medium-size 4 to 5 seat saloon, available with two or four doors; its appearance is characterized by a remarkably large boot, a backward-raked rear light—as on the Anglia—and Lucas paired headlamps. The car is only the second in normal production in Britain to embody this improved headlamp equipment. Moreover, it is the first British quantity-produced family saloon of less than 1½ litres to be fitted with disc type front brakes.

No alteration has been made to the bore of 80·96 mm, but the stroke has been increased from 48·41 mm to 65·07 mm; and, at 0·803 : 1, the stroke : bore ratio is still lower than average. To avoid the need of a deeper block, the connecting rods have been shortened from 4·612 in to 4·284 in between centres, so the ratio of their length to the stroke has been reduced from the relatively high 2·42 : 1 of the Anglia unit to 1·67 : 1. Since the partially hollow cast iron crankshaft of the Anglia has proved entirely satisfactory, even for Formula Junior racing, it is not surprising that the new component is of similar design and has the same journal diameters. In consequence of the last fact, the main and big-end bearing shells of the two engines are interchangeable.

On account of the scale effect, the standard compression ratio of 8·5 : 1 is slightly lower than that of the smaller engine, which is 8·9 : 1. Because the pistons are common to both units, the correct clearance volume on the larger engine has been obtained by the use of a new cylinder head casting with deeper bath tub type combustion chambers, which again are fully machined. Also common are the valves and springs, but the camshaft of the the Classic 315 engine has a higher lift and modified timing to provide adequate breathing at high r.p.m. In place of the Solex 30 ZIC-2 carburettor of the 997 cm³ unit, a Zenith 32VN instrument is fitted; since in each case the type number indicates the choke diameter in millimetres, the increase in choke area is relatively small.

It is interesting to compare the various performance figures with those of the 997 cm³ version. The increase of 34½ per cent in the swept volume has been accompanied by rises of 38½ per cent in the maximum net power output and 40 per cent in the net torque: maximum power occurs at much the same speed in each case, but the speed at maximum torque of the larger engine is the lower by 200 r.p.m. Evidence of the development work carried out is given by the increase in the maximum net b.m.e.p. from 131 to 136·5 lb/in².

Other comparative figures for the two engines are as follows, those of the 1,340 cm³ unit being quoted first in every case. Ratio of maximum torque : torque at maximum b.h.p, 1·28 : 1 and 1·29 : 1; ratio of speed at maximum torque : speed at maximum power, 0·51 : 1 and 0·54 : 1; b.h.p/litre, 40·3 and 39·1; b.h.p/in² of piston area, 1·69 and 1·22; b.h.p./lb of engine dry weight, 0·225 and 0·178; b.h.p/ton of vehicle kerb weight, 59·8 and 53·8. In the last instance, the weight of the two-door version of the Classic 315 is taken, because the Anglia has a body of that type, and so the comparison is direct.

Although the diameter of the clutch, 7¼ in, is the same as

Left: The low and falling bonnet line of the Consul Classic 315 affords excellent vision ahead. This view shows the four-door version. Above: As on the Anglia 105E car, the rear light is flat and has a rearward rake; a capacity of 21 ft³ is quoted for the boot, in which the spare wheel stands vertically behind one arch

on the Anglia, stronger springs are employed, and the withdrawal mechanism has been modified to minimize the pedal effort. The gearbox is common to both cars, as is the hypoid bevel final-drive unit. However, the half-shafts and the tubular portions of the axle casing are longer because of the 3·7 in wider rear track of the Classic 315. In addition, the new car is fitted with 5·60—13 in tyres, as against the 5·20 in section of those of the Anglia, so the road speed per 1,000 r.p.m. has risen from 16·09 to 16·47 r.p.m. in top gear.

As on all Ford cars manufactured in Europe, MacPherson front suspension is employed; however, all the major components differ from those of the other vehicles concerned. Mention should perhaps be made that the development of this suspension system has been marked by a trend towards greater lateral inclination of the telescopic struts. On the original Consul and Zephyr Mark 1 models, the range of inward inclination of the struts, which of course varies with suspension movement, was from 2¾ to 4 deg, and it was increased to 3½ to 5 deg on the 100E models and 3½ to 4½ deg on the Mark 2 cars; on the current Anglia, or 105E, a further increase to 4¾ to 6¼ deg was made, and on the new vehicle the range is 6½ to 7¾ deg. Not only does the greater inclination reduce the offset of the king-pin axis from the centre of the tyre contact patch—thus reducing steering effort—but it also permits a slightly lower bonnet level for a given length of strut.

An orthodox rear suspension layout has been adopted. It is understood that the possibility of using independent suspension was thoroughly investigated during the design and development stages of the car. The decision in favour of the live axle system was made on the grounds that superior characteristics of ride and stability could be obtained only by introducing a commercially unacceptable degree of elaboration. In addition to the normal bump stops, the suspension incorporates rubber snubber blocks, mounted on the underside of the body structure, one immediately above each spring and towards its front end. The main function of these snubbers is to limit wind-up of the axle, but they also provide an increase in the effective spring rate at large bump deflections. For the rear suspension, the spring rate, periodicity, roll centre height and roll stiffness are respectively 98·5 lb/in, 80 c/min, 9·13 in and 128 lb-ft/deg; the corresponding figures for the front suspension are 86 lb/in measured at the wheel, 74 c/min, 4·01 in and 266 lb-ft/deg.

In the braking system of the three larger models, which is generally similar to that of the Classic 315, a vacuum servo is provided. However, the lower weight of the new vehicle makes servo assistance unnecessary. A swept area of 218 in²/ton kerb weight is provided by the brakes, which are of Girling manufacture. In the case of the front disc units, the pads are of the hydrostatic self-adjusting type, and the inboard surfaces of the discs are shrouded, to exclude water and road dirt and thus equalize the rate of wear on the two pads.

In its general construction, the unitary body shell follows well-established Ford practice. Although the boot is relatively shallow, it has a capacity of no less than 21 ft³; its exceptional length, of 46½ in, permits the spare wheel to be stowed vertically at the extreme left-hand side, behind the rear wheel arch. Because the full capacity of a boot is, in general, rarely used, it may be questioned whether the additional weight and overhang involved are warranted. Nevertheless, there is no doubt that a really spacious container is nowadays regarded as a desirable feature, especially in export markets.

The Classic 315 has a broader and lower appearance than the other British Fords, and its main dimensions are given in the accompanying table. For comparison with the Anglia, the ratios of wheelbase : overall length, wheelbase : track and track : overall width are given below for the two cars, those of the newer car being quoted first. The figures are, respectively, 0·58 : 1 and 0·589 : 1, 2·0 : 1 and 1·97 : 1, and 0·76 : 1 and 0·802 : 1, so the variations are small.

SPECIFICATION DATA

Engine

Number of cylinders 4
Bore 80·96 mm
Stroke 65·07 mm
Swept volume 1,340 cm³
Compression ratio 8·5 : 1; 7·2 : 1 optional
Maximum b.h.p. (net) 54·0 at 4,900 r.p.m.
Maximum b.m.e.p. 136·5 lb/in² at 2,500 r.p.m.
Maximum torque 74 lb-ft at 2,500 r.p.m.
Crankshaft Three-bearing, cast iron, with hollow big-end journals and flying webs
Cylinder Head Cast iron, with bath tub combustion chambers and vertical push rod operated valves
Carburettor Zenith 32VN, with 32 mm choke
Fuel pump AC mechanical
Dry weight 240 lb, including clutch

Transmission

Clutch Ford single-dry-plate, 7½ in diameter, with hydraulic actuation
Gearbox Four-speed, with synchromesh on second, third and fourth
Gear ratios

fourth	1 : 1
third	1·412 : 1
second	2·396 : 1
first	4·118 : 1
reverse	5·404 : 1

Dry weight 68 lb, including bell housing
Propeller shaft Open type, with needle roller bearing universal joints

Rear axle

Type Semi-floating, with hypoid-bevel reduction
Ratio 4·125 : 1

Suspension

Front Single transverse links, with anti-roll bar serving as radius arms; near-vertical telescopic struts, embraced by coil springs and containing Armstrong dampers
Rear Asymmetrical semi-elliptic leaf springs, with Armstrong lever type dampers

Steering

Type Burman recirculating-ball
Ratio 15·88 : 1
Turning circle 34 ft
Turns from lock to lock 3

Brakes

Front Girling hydraulic disc type, with 9½ in diameter discs; total swept area, 98·4 in²
Rear Girling hydraulic drum type, with 9 in diameter drums and 1¾ in wide shoes; total swept area, 99 in². Mechanical actuation by handbrake
Distribution of braking effort
front 66 per cent
rear 34 per cent

Wheels and Tyres

Wheel type Pressed steel disc, with four-stud attachment and 4 in wide rims
Tyres 5.60—13 in tubeless
Pressures, normally laden
front 22 lb/in²
rear 24 lb/in²

Dimensions

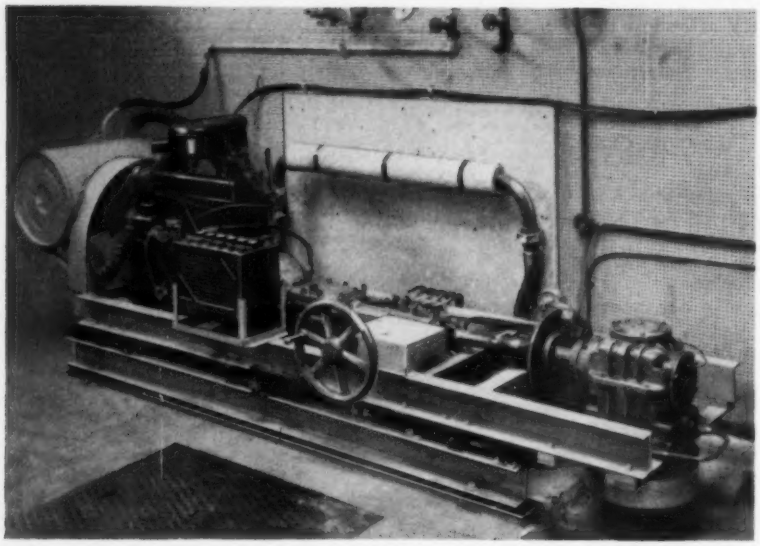
Wheelbase 8 ft 3 in
Track 4 ft 1½ in
Overall length 14 ft 2¼ in
Overall width 5 ft 5½ in
Overall height 4 ft 6½ in
Ground clearance 6½ in
Frontal area 18·9 ft²
Kerb weight
two-door saloon 2,025 lb
four-door saloon 2,080 lb
Weight distribution
two-door —front, 50·5 per cent
rear, 49·5 per cent
four-door —front, 50·7 per cent
rear, 49·3 per cent

Adhesive for Bonnet Lid

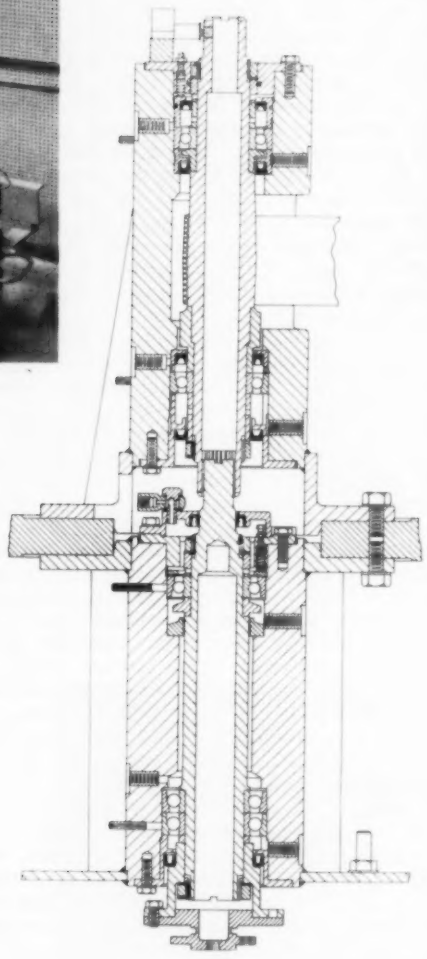
USING an adhesive formulated from synthetic rubbers, the Ford Motor Co, U.S.A, have joined together the outer panel and inner reinforcing sections of a bonnet lid. Because of the large size of this assembly, the width of which is almost six feet, it is necessary to reinforce the outer panel with an inner panel over its entire area, otherwise fluttering of the bonnet would occur at high speeds.

Advantages claimed for the use of the adhesive are that the weight of the whole assembly is reduced, the process can be rapidly effected automatically and it helps in respect of damping. The adhesive used, EC-2150, is made from synthetic rubber by the Minnesota Mining Co. It was specified that the adhesive must be capable of sticking to oily metal and then, after a short period of air drying, withstanding the cleaning and bonderizing processes that are applied to the assembly. Curing of the adhesive has to take place, without any possibility of embrittlement, during the normal paint baking process. Throughout the life of the car, the properties of the adhesive have to be maintained in all climates, from the coldest to the warmest. In addition, it has to be flexible enough to withstand the vibration caused by the engine and by slamming the lid. At the plant, the adhesive is applied to both sheet metal parts; then the panels are placed together and the edges of the bonnet assembly welded. The maximum strength, of approximately 80 lb/in², of the adhesive is developed in the paint-drying ovens.

Testing of Clutches to Destruction



Left: A 2 litre automotive engine and gearbox are used as the prime mover; the drive is turned through a right angle by a spiral bevel unit. Below: The vertical shaft assembly is belt driven and carries the test specimen



Burst Chamber for High-Speed Tests, Designed and Installed by Automotive Products Group

FOR many years, an essential part of the research and development activities of the Automotive Products Group's central engineering department has been the carrying out of centrifugal bursting tests, particularly on Borg and Beck clutches. Some time ago, however, it became apparent that the available facilities were becoming inadequate: the larger types of clutch could not be accommodated in the existing burst chamber, and the rotational speed of smaller units was limited to 12,000 r.p.m. A new chamber has, therefore, been installed in one of the bays of the group's recently erected test house at the Leamington Spa factory.

This chamber was designed in the research department and built and installed by the experimental department. It can accommodate test assemblies of up to 2 ft diameter and weighing up to about 200 lb. The maximum rotational speed is 20,000 r.p.m, which should be sufficiently high to meet all requirements for many years to come. Initial proving runs were carried out during 1960, and the chamber is now in regular use. As can be imagined, numerous problems had to be overcome at the design stage, not the least of which was that of providing adequately for the safety of the operators. For this reason, the chamber itself is sunk below floor level, and the instruments and controls are situated in a separate room.

One of the accompanying illustrations shows the general layout of the installation. The actual test equipment consists of two groups, the power unit and the belt-driven vertical shaft assembly. It is housed in a portion of the bay measuring about 21 ft long × 11½ ft wide × 11 ft mean height; the roof is slightly sloping. To keep the noise to a reasonable level, the walls are lined with pegboard on top of a layer of acoustically dead material. Electric heater elements of the tubular type are installed along the bottom of the walls, so that the ambient temperature can be controlled. When a test unit is to be fitted or removed, the vertical shaft assembly is lifted clear of the pit, by means of a 20 cwt hoist, and is lowered on to a wheeled stand. Removal of the assembly in this way also facilitates maintenance of the pit, whenever this work is necessary.

Power unit

The prime mover is a well known four-cylinder automotive petrol engine of just over 2 litres swept volume. It it installed complete with its standard clutch and three-speed gearbox, and a battery is provided for starting. A petrol engine and gearbox were chosen for the duty rather than an

electric motor because they represented the cheapest means of obtaining an infinite variation of speed, over the desired range, together with a variable torque output.

Since no cooling draught is provided, and there is the possibility of the occasional prolonged test run, the radiator and coolant capacity are larger than in the case of the car installation. A 20 gal fuel tank is mounted in the shop and is replenished as necessary directly from the bulk storage tank for the test house. The exhaust gases are led from the manifold through a 3 in bore pipe to an expansion chamber, and thence into the central exhaust system.

A short propeller shaft connects the output shaft of the gearbox to a Croft 1:1 spiral bevel gear unit, which turns the drive from the horizontal to the vertical. To avoid the need of great precision in the alignment of the two assemblies the propeller shaft embodies two universal joints of the needle roller bearing type, and a splined, sliding coupling. Bolted to the flanged end of the input shaft of the gear unit is a Lockheed 11 in diameter disc brake, of the type fitted to the Austin A.99 and Wolseley 6/99 cars, which is used only if an emergency demands the immediate stopping of the plant.

Long-term reliability of the Croft gear unit is ensured by pressure lubrication of the gears. Oil is sprayed at the meshing faces of the teeth by means of an external oil pump driven by a small electric motor. Mounted on the output shaft of the unit is the $11\frac{7}{8}$ in diameter pulley for the flat belt that drives the vertical shaft assembly. The pulley is crowned, to minimize any tendency of the belt to run off owing to the horizontal layout of the drive.

The engine and auxiliary equipment are mounted on a sub-frame built from channel section joists. In turn, the sub-frame is carried on slide rails on the fixed bed of the unit, on which it can be moved longitudinally by means of a rack-and-pinion winding mechanism. This mechanism can be locked in any position, and it enables the tension of the driving belt to be adjusted. The belt of the drive, which has a step-up ratio of 5:1, is of Mintex manufacture and is made of silk; its length, width and thickness are respectively 12 ft, 3 in and $\frac{1}{8}$ in. According to the makers, it should have a minimum initial tension of 500 lb for output shaft speeds of up to 15,000 r.p.m.

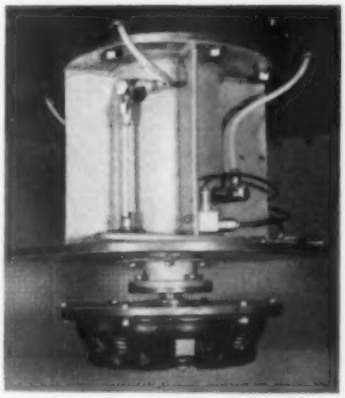
Vertical shaft assembly

In view of the high speeds and heavy belt pull involved, two obvious essentials of this assembly are adequacy of the bearings and careful balancing of the rotating parts. At an early stage in the design phase, it was felt that both these requirements would best be met by dividing the unit into upper and lower portions, an arrangement that would also facilitate installation. Each portion consists basically of a shaft running in bearings mounted in a fabricated steel housing; the upper shaft is driven by the belt and the lower one carries the test specimen. Sandwiched between the two sub-assemblies is the circular steel plate that forms the lid of the burst chamber. This plate has a diameter of 4 ft and is $1\frac{1}{2}$ in thick.

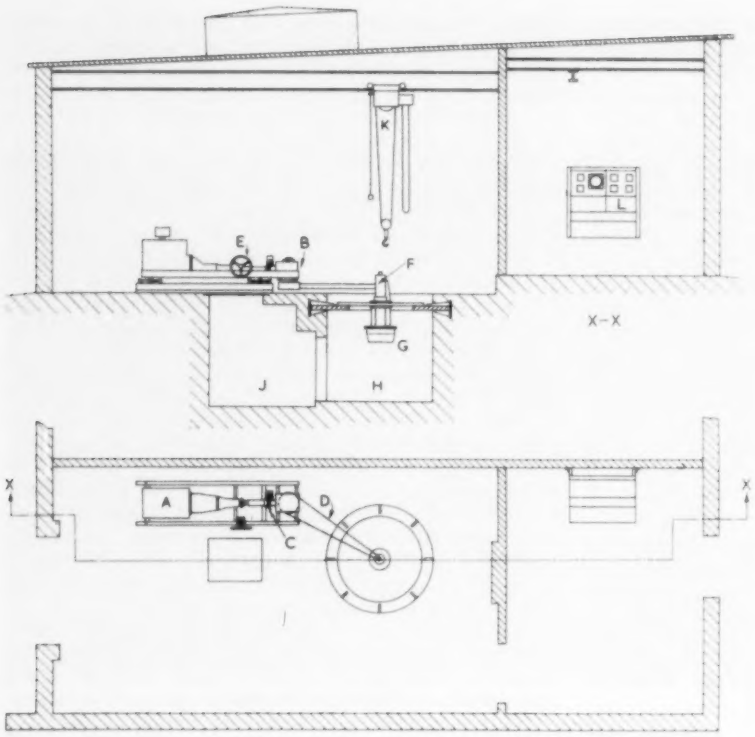
The main element of the upper housing is a thick-wall steel tube. At its lower end is a male spigot that fits into the bore of a base flange, to which it is welded; the joint is braced by three triangular gusset plates. Clearance for the driving belt is provided by cutting away part of the housing wall. The upper shaft, which is hollow throughout its length and is made of En.100 steel, embodies the $2\frac{3}{8}$ in diameter crowned pulley for the belt. It is carried in two Ransome and Marles angular-contact ball bearings of 45 mm bore, mounted in opposition in the housing, one above and one below the pulley. Since these bearings are positively lubricated, as will be explained later, an oil seal is installed above and below each. End float is avoided by spring loading the shaft downward: for this purpose, six helical springs are employed, each of which exerts a thrust of 35 lb. The springs are situated in the bolted-on top cover of the housing, above the upper bearing, and their load is applied to a flanged sleeve that surrounds the top oil seal and bears on the outer race of the bearing.

The shaft of the lower sub-assembly is also of En.100 steel; it is hollow over most of its length, but its upper end —which is of reduced diameter—is solid. On the portion of smaller diameter are machined splines that are a sliding fit in similar splines in the bore of the upper shaft. Since this sub-assembly is directly subjected to the weight of the test unit, and the stresses imposed by it, the shaft runs in three bearings, which again are of the axial-contact type. Two of the bearings have a bore of 50 mm and are mounted in tandem, near the bottom of the shaft, while the third, which has a 45 mm bore, is installed in opposition near the top of the shaft. In this instance there are only two oil seals, one at the top and the other at the bottom of the sub-assembly. Again, the shaft is spring loaded downward, this time by nine springs each giving the same thrust as those already mentioned. The installation of the springs is similar to that of the other set, but they bear on a thrust washer immediately above the upper bearing. On the lower end of the shaft is mounted a flanged half-coupling, which clamps the inner races of the lower bearings against a shoulder.

There are welded-on flanges at the top and bottom of the thick-wall tubular housing for the bearings; the flanges are bridged by four equally spaced, radially disposed gusset plates, which are welded to the tube as well as to the flanges.



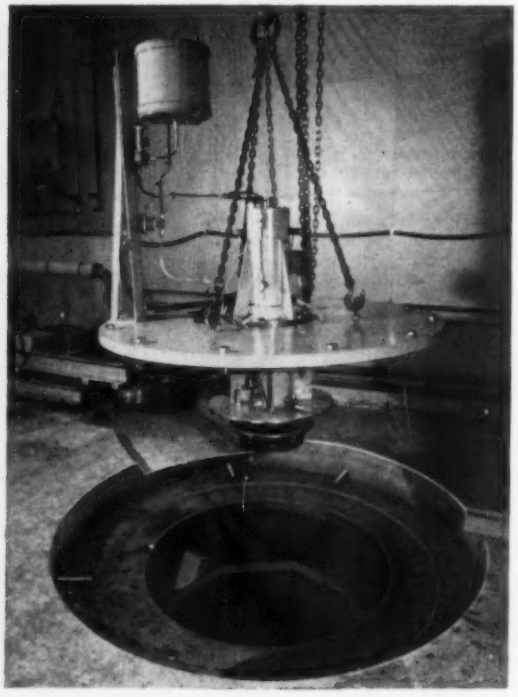
Right: A shear neck is installed between the clutch and the flange on the bottom of the drive shaft; there is a gravity oil feed to the bearings of both portions of the shaft. Below: The container for the oil supplied to the bearings can be seen above the casing of the shaft assembly



General arrangement of the installation. As a safety measure, the instruments and controls are situated in a separate room, adjacent to the test shop. The cover of the pit, which is a part of the vertical shaft assembly, is very rigidly supported

A *engine and gearbox;* **B** *spiral bevel gear unit;* **C** *disc brake;* **D** *driving belt;* **E** *hand wheel for belt tensioning;* **F** *vertical shaft assembly;* **G** *test specimen;* **H** *burst pit;* **J** *access chamber;* **K** *20 cwt hoist;* **L** *control and instrument panel*

The depth and diameter of the burst pit are both 5 ft. Within the pit can be seen the timber facing, which is 10 in thick, and the octagonal steel sleeve that is installed to protect the timber from damage should no metallurgical examination of the components be required after the completion of a test run



The adjacent flanges of the upper and lower housings both have a male spigot that fits into a hole bored in the lid plate of the pit; the assembly is held together by six $\frac{7}{8}$ in diameter bolts passing through the flanges and the plate. It should be pointed out that the bottom flange of the lower housing is not structural but forms part of the protection of the lubrication system against flying fragments; this protection is completed by a $\frac{1}{2}$ in thick steel cylinder that fits between the flange and the lid plate.

The lubrication system for the bearings is very simple. Oil is contained in a 1 gal tank, which is mounted on a pedestal bolted to the lid plate. From this tank it is fed under gravity to the upper side of each bearing. After passing through the bearings, the oil is returned to the tank by means of an S.U. electric pump of the type used for fuel feed purposes on motor vehicles.

To minimize the risk of damage to the shaft assembly, should excessive out-of-balance forces develop during a test, the test specimen is not mounted directly on the end of the lower shaft. Instead, it is attached to a shear neck, which in turn is bolted to the flange at the bottom of the shaft. Spigots are used to ensure coaxiality between the shaft, the shear neck and the test specimen. The shafts were, of course, very carefully balanced dynamically before assembly, and great care was taken to ensure accurate alignment of all the bearings. In addition, the shear necks are made to close tolerances and before a clutch is installed for test, its balance is checked, using the shear neck as a datum. It is a tribute to the accuracy of manufacture that no rebalancing of a standard clutch has yet been found necessary in the test house.

When the new burst chamber was first put into service, considerable difficulty was experienced in accelerating large-diameter clutches, owing to their high air drag in the confined space of the pit. This problem was solved in an ingenious yet simple way: the clutch in enclosed in a domed steel cover, which is bolted to the stationary base flange of the lower bearing housing; then, before the test run is started, the air is evacuated from within the cover, to a depression of 26 to 28 in Hg. This reduction in pressure has been found sufficient to enable even the largest clutches to be readily

accelerated. Since the covers, clearly, are expendable, they are not made to high standards of precision, except in respect of the mounting flange, to ensure a good seal. A secondary advantage of this method of enclosure has been a marked reduction in the noise experienced during running.

Layout of burst pit

Both the diameter and the depth of the burst pit are 5 ft. The pit is lined with mild steel plate ½ in thick, over which is a 10 in thick sheathing of timber; the timber is used to avoid unnecessary damage to components flung off when the specimen bursts. This timber is actually that of old railway sleepers, and it is fitted in short sections to facilitate replacement.

Considerable tearing of the timber can occur during a burst and, because frequent replacement would prove relatively costly, a steel sleeve is fitted within the sheathing for any tests in which no subsequent metallurgical examination of the ejected fragments is required. This sleeve is made of 1½ in thick mild steel plate and, for simplicity of fabrication, is of octagonal form. It is lowered into the pit by means of the hoist, and is fixed in position by wooden wedges.

The seating for the lid plate of the vertical shaft assembly is embedded in the concrete of the pit, just below floor level. It consists of a thick steel annulus—of considerably larger overall diameter than the pit—to the periphery of which is welded a flange ring. Flexing of the seating is resisted by radially disposed, triangular gusset plates, which are welded to both the flange and the annulus, above and below. The lid plate is secured to the annulus by twelve ¾ in bolts.

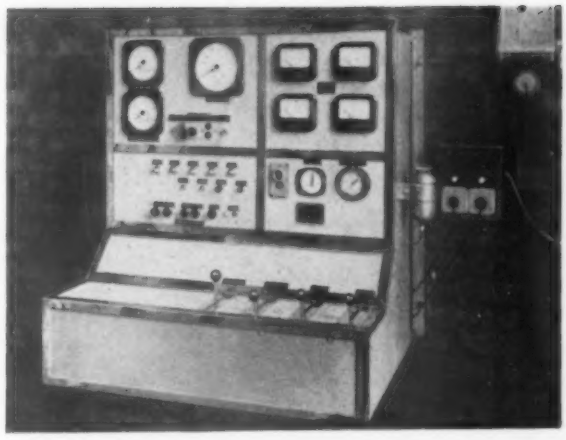
Adjoining the burst pit is an access chamber, entered through a manhole in the floor. This chamber enables any minor adjustments to be readily made to the test assembly after the lid plate has been bolted down. Without access from beneath, the amount of work involved in making such adjustments would clearly be considerable.

Controls and instrumentation

An accompanying illustration shows the general layout of the control and instrument panel in the room adjacent to the test shop. At the bottom of the panel are the control levers for the engine throttle, clutch, gear selection and disc brake. The throttle, clutch and brake are actuated by means of conventional hydraulic systems comprising master and slave cylinders, and the appropriate piping. Gear selection, on the other hand, is effected pneumatically, only second and top ratios being used: it has been found that an ample speed range of the vertical shaft can be obtained without recourse to the lowest ratio, with a resultant simplification of the control system.

The rotational speed of the vertical shaft is accurately shown on an electronic tachometer, the largest instrument on the panel. This tachometer can be operated over either of two speed ranges—from 0 to 10,000 r.p.m. and from 0 to 20,000 r.p.m. A refinement that will be embodied in due course is a device that will cause the needle to be held at the maximum speed reached during a test, that is, the speed at which failure occurred and the throttle was shut. To the left of the tachometer are two vibration amplitude meters, one for horizontal and the other for vertical vibrations. They are connected to pick-ups on the shaft assembly, and below them are grouped their switches, calibration controls and indicator lamps, all of which are labelled to indicate their functions.

Because of the heavy duty to which the vertical shaft bearings are subjected, it was thought advisable to record their temperatures, though, in fact, no overheating has so far occurred. Each bearing assembly is, therefore, fitted with a standard thermocouple, and the temperatures are shown on four galvanometers fitted to the upper right-hand section of the panel. Also mounted on the panel are the starter button and gauges recording oil pressure and engine water temperature. It is worthy of mention that the company's research staff constructed the electronic equipment of the installation, except for the actual tachometer, and that, for safety, all electrical equipment is of the flame-proof type.



All the controls and instruments are mounted on a single panel; the largest instrument is an electronic tachometer. Gear selection is effected pneumatically, but the other controls have hydraulic actuation

Anti-Theft Devices and Slide Rules

IN THE May issue of "Which?", there are articles reporting on investigations into the value and effectiveness of a selection of 29 slide rules and 13 different anti-theft devices for motor vehicles. In the case of the anti-theft devices, the testers were the Vice-chairman of the Road Haulage Association's Vehicle Security Committee and two ex-police driving instructors. The slide rules were submitted to wear tests and to three months' normal use. "Which?" is the publication of the Consumers' Association Ltd, 14 Buckingham Street, London, W.C.2.

Computer Exhibition

INFORMATION has been received that the 1961 Electronic Computer Exhibition will take place from the 3rd to the 12th October, in the National Hall at Olympia, London. A number of major advances has been made since the previous exhibition in 1958, so there should be much to interest present and potential users of this type of equipment. The exhibition is organized jointly by the Office Appliance and Business Equipment Trade Association and the Electronic Engineering Association.

Upholstery Foam

A NEW polyether foam for use in seat cushions has been introduced by Aeropreen Products Ltd, Lindsay Avenue, High Wycombe, Bucks. It has the designation AOP22 and is a quick-recovery material that combines a low density —26 kg/m^3—with a compression set of less than 10 per cent. The manufacturers consider a higher set than this to render a foamed plastics material unsuitable for use in cushions, because the reduction of the dimensions in service soon causes the cover to become a loose fit, with consequent creasing and poor appearance. Further information on the AOP22 foam can be obtained from the manufacturers.

Cleaning Intricately Cored Castings

Leyland Motors Ltd. Develop Molten Caustic Soda Plant for De-sanding Diesel Engine Cylinder Heads

AT the Farington Foundries of Leyland Motors Ltd, a supplementary cleaning process for diesel engine cylinder heads has recently been introduced. This process ensures that the relatively intricate and largely inaccessible internal passages of the casting are completely freed from residues of core sand. In such castings, even with the application of modern coremaking techniques and comprehensive vibrating, washing, and shot-blasting routines, it was hitherto not possible to guarantee the complete dislodgment and removal of entrapped sand.

This problem has been overcome satisfactorily and economically by immersing the castings in a bath of molten caustic soda. The plant was designed and built by Leyland Motors engineering departments working in close collaboration with Imperial Chemical Industries Ltd. and Thermic Ltd. Use was made of data obtained from trials conducted on a pilot plant set up at the Alkali Division of I.C.I. Ltd, at Norwich.

Because of the nature of the process it was decided to house the plant in a separate building adjoining the castings processing section of the foundry. This relative isolation permitted the unimpeded application of the necessary safety measures and thus ensured the provision of the best possible working conditions for the plant operators. Sited conveniently adjacent to the fettling bay, and alongside the normal flow path of the castings, the processing plant is divided into four, sequenced sections. These stages are for the preheating, caustic soda immersion, draining and cooling and, finally, cold quenching and hot rinsing of the castings. The overall cycle time for the castings in each stage is 30 min. Following shot-blasting and rough cleaning operations, the castings are loaded into stout wire mesh baskets and transferred to the preheating oven where they are heated for 25 min and reach a temperature of 130-150 deg C.

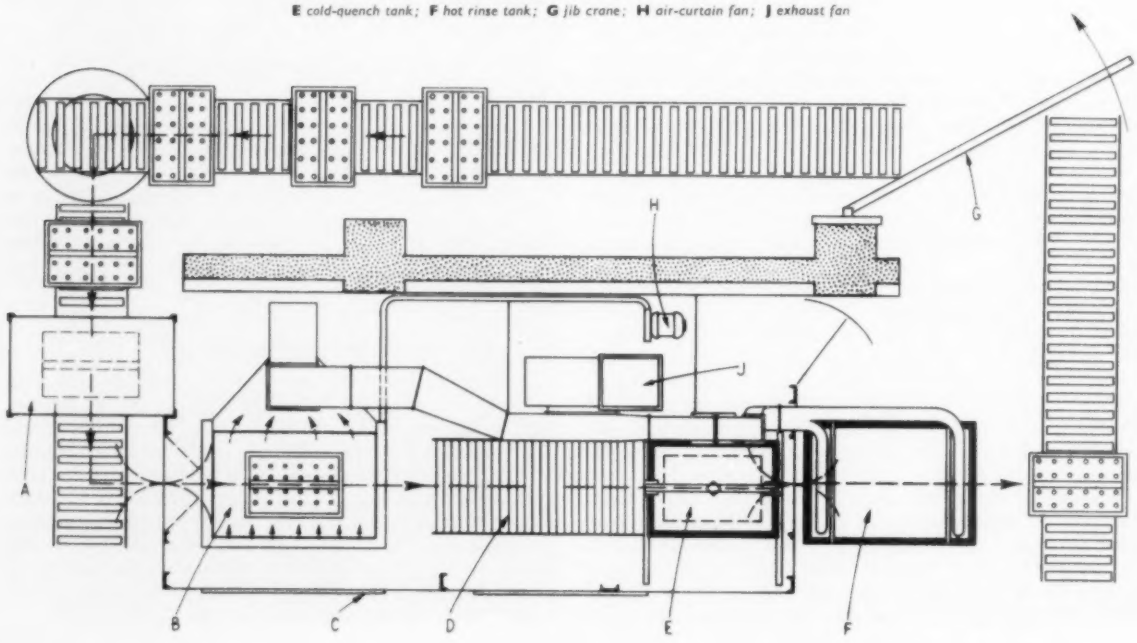
The caustic bath

The purpose of the preheating operation is threefold. It is to ensure that the castings are completely dry, to reduce the thermal shock to the castings in the caustic bath, and to relieve the thermal load on the caustic bath.

After preheating, the basket of castings is picked up by one of two overhead monorail-mounted hoists, carried through screening doors, and lowered into the molten caustic bath. The tank is fabricated of mild steel, 1 in thick, and holds 3·5 ton of caustic soda. Heating is indirect, by means of gas burners. Castings remain in the bath for 25 min at a nominal temperature of 500 deg C, and are then lifted and allowed to drain over the bath for 3 min. For a further period of 20 min the basket of castings is deposited on an adjacent drain table, the hoist being disengaged and returned ready to pick up the next basket. During this time the castings lose heat, cooling down to approximately

Molten Caustic Soda Casting De-sanding Plant

A *preheating oven;* **B** *molten caustic soda bath;* **C** *safety screen;* **D** *drain table;* **E** *cold-quench tank;* **F** *hot rinse tank;* **G** *jib crane;* **H** *air-curtain fan;* **J** *exhaust fan*



Withdrawing a basket of cylinder head castings from the preheating oven on the roller track, for transfer to the molten caustic bath

A basket of castings being lowered into the screened caustic bath. In normal operation the enclosure door at the right is closed

250-280 deg C and thereby lessening the thermal shock to the castings in the next stage, the cold-quench.

There is a continuous flow of water through the cold-quench tank, and the basket is twice lowered into the water to rinse out the internal passages of the castings as thoroughly as possible. A feature of the tank is that it is deep enough for the basket to be admitted and the tank lid closed before the basket is lowered further for immersion. After 10 min the basket of castings is lifted out and transferred to a hot-rinse tank where the washing is completed by a further immersion for 15 min. The basket is again raised and lowered in order to rinse out the interiors of the castings. A small flow of fresh water is maintained through the hot tank and the temperature is held at 80 deg C, which is high enough for the castings to be self-drying after their final removal from the tank.

To facilitate sludge removal, two trays are provided in the bottom of the caustic soda tank. These are lifted out at the end of each shift, carrying much of the sludge with them. The remainder of the sludge is removed by means of a long-handled scoop. With the type of work being treated, the loss of caustic soda due to the drag-out and also the sludge removal amounts to an average of 44 lb per ton of work processed. This loss is made up regularly by additions of flake caustic.

Safety precautions

Special attention was given to the design of the fume-extraction system to ensure good working conditions in the area. Powerful extractors are fitted over the caustic soda bath and over the cold-quench tank. In addition, a curtain of fresh air is blown over the top of the caustic tank to provide better ventilation control. The caustic tank, draining table, and cold-quench tank are all completely screened as a precaution against splashing of the caustic, and the operator manipulates the charges from outside the safety screen.

Baskets of castings gain access to and egress from the screened section through double swing doors. The floor of the drain area inside the screen and the working area outside the screen is covered by metal gratings to allow splashed liquids to drain away to a sump and also to facilitate cleaning. Overflows from the cold-quench and hot-rinse tanks are also collected in the sump. After the sludge has been separated out, the effluent is not strongly caustic and is accepted in the normal sewage system.

In designing the plant, every possible precaution has been taken to reduce to the minimum the hazards which exist when dealing with caustic soda. The operator must always wear goggles and a protective helmet against the unlikely event of splashes coming out of the screened area. If entry into this area is necessary for the de-sludging operation or other tasks, special protective clothing and a helmet with a hood must be worn. As a further precaution, buffered phosphate solution is readily available at convenient points in the plant; in eye-wash bottles for immediate use and as a bulk supply to flood any affected part of the person. Operators have been instructed how to give immediate first aid on the spot in the unlikely event of a mishap and strictly briefed in the need at all times to observe reasonable routine precautions.

In particular, they are urged to avoid acquiring an easy familiarity with the caustic material. Printed warning notices are posted at various points in the plant to serve as constant reminders to observe the safety regulations.

Immersion of the castings in the hot-rinse tank. The cold-quench tank to the left is screened to shield the operator from splashes

New Plant and Tools

Recent Interesting Developments in Production Equipment

RECENTLY announced by Black & Decker Ltd, of Harmondsworth, Middlesex, is a pistol-grip electric drill that incorporates a series of power cells and therefore can be used independently of mains power supplies. This revolutionary development in the sphere of portable tools will be of less importance to the production engineer than to the maintenance engineer, since the portable tools employed on modern production lines are not required to be used any great distance from convenient sources of power. A limitation is that the power cells, at this stage of development, have to be recharged after approximately 75 holes of $\frac{1}{4}$ in diameter have been drilled, and recharging takes five hours. For maintenance and repair purposes, however, particularly where extreme mobility is demanded, a self-contained portable drilling machine can be of tremendous value.

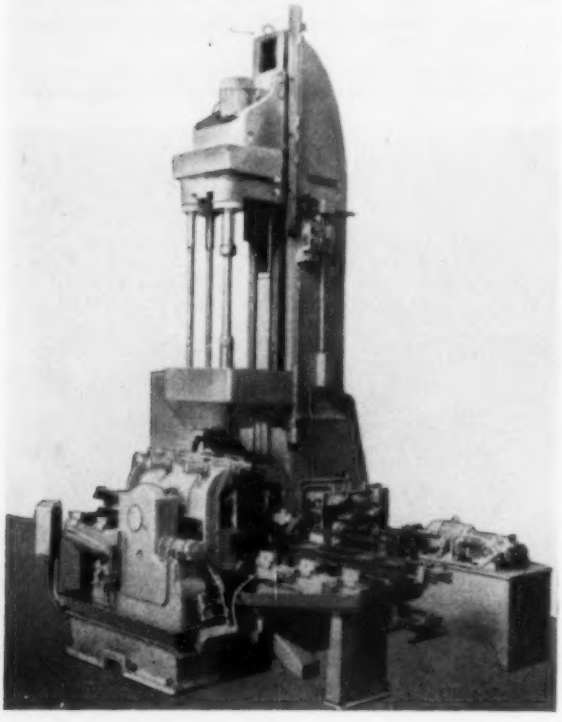
A light alloy die-casting encloses the motor, and the butt is formed of plastics material. The machine, which weighs only 4 lb, is designed for one-handed use, and is similar in size to conventional pistol-grip drilling machines. Since the power cells can be recharged 400 times, a life equivalent to the drilling of 30,000 holes is forecast, after which the cells have to be renewed.

Recharging is a simple process, and is done by connecting the machine to a conventional source of electric power for a period of either five or ten hours, according to preference.

Power cells inside the body of this portable drilling machine are recharged from an electrical mains supply without being removed
(Black & Decker Ltd.)

The shelf-life after recharging is said to be three months. No details can yet be given of either the motor or the power cells in the machine, which will go into production later this year.

This vertical, three-spindle boring machine, for crankshaft and camshaft bearing housings in cylinder blocks, has a stroke of 48 in and occupies considerably less floor space than would a more conventional machine
(Foote-Burt Co.)



Long stroke vertical boring machine

A machine for the in-line finish boring of crankshaft and camshaft bearing housings in cylinder blocks is being manufactured by the Foote-Burt Company, Cleveland, Ohio, U.S.A. It has a 48 in stroke and is arranged for vertical operation, so that a considerable saving in floor space is afforded by comparison with that required for a conventional horizontal machine.

At the beginning of a work cycle, the block is fed into a fixture in the work area which is then tipped up, so that the axes of the holes to be bored are appropriately aligned. Prior to the start of the cutting operation, the boring bars descend rapidly until pilot guides register with the holes to be bored; rotation of the bars does not begin until the cutting tools have begun to enter the holes, otherwise the long, slender shafts would whip if not restrained. A time switch ensures that the spindles attain their full cutting speed before the downward feed begins.

At the end of the cycle, the tools retract and the block, in its fixture, is indexed forward, to be replaced by the next one. A production rate of 15 blocks per hour at 80 per cent efficiency, and an accuracy of $\pm 0{\cdot}0005$ in in diameter over the whole 48 in of travel are claimed for this machine, which has an overall height of 18 ft. Power is supplied by a 5 h.p. motor, and the head is counterweighted to ensure positive tool retraction in the event of hydraulic power failure.

Electronic grinding indicator

Frequently, the operator of a surface or spindle-grinder has to rely on his hearing to tell him when the grindstone is making first contact with the workpiece, but in many workshops the high noise-level can make this an unreliable method. In such cases, and when the nature of the work makes it impossible to go by normal visual indications, an artificial means of indicating contact is extremely useful.

An electronic indicator for this purpose is being marketed by B. O. Morris Ltd, Morrisflex Works, Briton Road, Coventry. It consists of an electrostrictive transducer which receives signals from a pick-up placed near the workpiece and translates them into easily understood patterns on a cathode ray tube, which the operator can watch while he is adjusting the settings of his grinding machine. This device is especially useful in three different circumstances: where remote indication is required; where no spark is visible; and where a very high degree of precision is essential. Other applications for this indicator are: in the detection of eccentricity; in conditions where work has had to be temporarily removed from a machine; and in indicating where work is tending to spring, giving a lighter cut than desired.

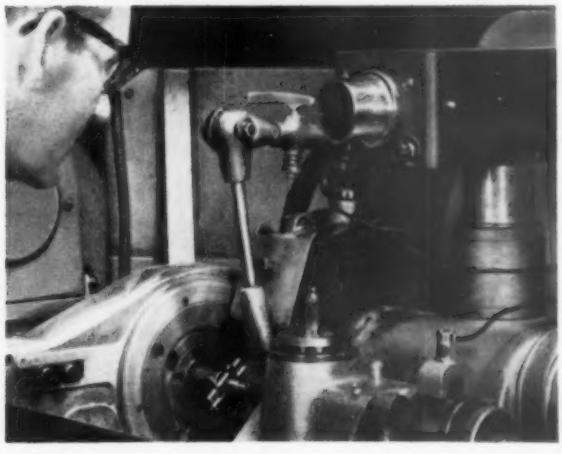
The pick-up detects the vibration caused by contact between the wheel and the workpiece. It is attached to the machine, by either a magnet or a fixture, on to which it can be screwed, close to the source of vibration but not close to any misleading source of vibrations such as chattering gears, worn bearings or intermittently contacting surfaces. For example, where work is supported between centres the best position for the pick-up is on the tailstock, and in the case of a surface grinder it should be on the table, close to the workpiece. The box containing the cathode ray tube is mounted on the machine, in a position such that the operator can view it comfortably while he is setting his machining controls.

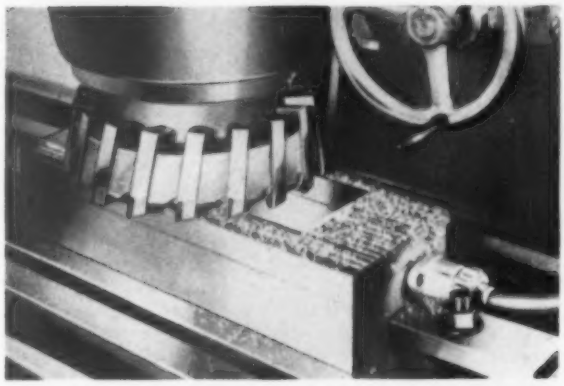
On the screen, the operator sees an inverted vee, which is faint and flickering when the grinding wheel is not contacting the workpiece, but which becomes bright and steady as soon as contact is made. When the arms of the vee lengthen and shorten rhythmically, it indicates eccentricity or springing of the workpiece, and when traces flicker between the ends of the arms, it means that a heavy cut, or excessive peripheral speed, is creating multiple frequencies. Among the controls of the indicator is one for eliminating unwanted high frequency vibrations on the screen. The equipment is designed primarily to operate at 240 V and 50 c/sec, but provision is made for its use with any supply voltage between 200 and 250.

Simultaneous tapping and deburring

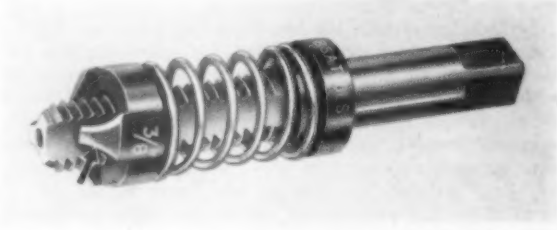
Almost invariably, the burr which stands proud of a surface in which a tapped hole has been made has to be either removed or allowed for in some way. The tapped hole itself can, of course, be chamfered or slightly counterbored, or the hole in a mating face can be so treated, in order to avoid a faulty joint between the two components. In either case, an operation in addition to tapping has to be carried out.

Affixed to the tailstock of this spindle-grinding machine is a magnetic pick-up, bottom right, which transmits signals to a cathode ray tube, seen at top right, when the grinding wheel first contacts the workpiece
(B. O. Morris Ltd.)





Thin plates and discs can be quite heavily machined on this magnetic chuck, which has narrow longitudinal pole divisions of the work face
(Magco Ltd.)



The arrow points to the cutting edge of the Burr-Bit, which chamfers the rough edge of a tapped hole while the tap is being withdrawn
(B.S.A. Small Tools Ltd.)

With the B.S.A. Burr-Bit it is possible to tap and chamfer a hole in one operation, thereby occasioning a reduction in time, floor space and operation cost required, as compared with conventional systems. As shown in the illustration, the Burr-Bit consists of three parts: a collar that is fixed to the shank of the tap by a small set-screw; a coil compression spring; and a bit blade. This blade is a ring shape chamfering tool with inward projections that register with the flutes of the tap; on the axial extensions of these projections are the chamfer-cutting edges, which, by virtue of their positions in the flutes, extend inside the core diameter of the thread.

The cutting edges are the trailing edges of the projections when the tap is descending, and do not, therefore, come into operation until the tap is withdrawn. During the descent of the tap, then, the blade idles around the edge of the hole, and simultaneously rides up the tap, thereby compressing the coil spring which imparts the downward thrust on the blade while the tap is reversed. It will be seen that the chamfering action cannot cause burring as the tap is automatically clearing the threads at this stage.

Burr-Bits are supplied to fit standard taps in the range 6 B.A. to $\frac{3}{8}$ in diameter, and are available with either two or three projections, to suit the number of flutes in the tap. The manufacturers, B.S.A. Small Tools Ltd, Montgomery Street, Birmingham 11, claim that by this method of chamfering it is possible to remove the burr with the minimum of chamfer, so that the largest practicable amount of thread is left, which, of course, is especially important where the material is thin. By adjusting the height of the collar on the tap, it is possible to vary the compression of the spring, and

therefore the amount of metal removed. The tapping of deep holes is facilitated by the fitting of a double conical spring in place of the standard spring, and may, in some instances, call for the flutes to be extended by grinding.

Forming the ends of tubes

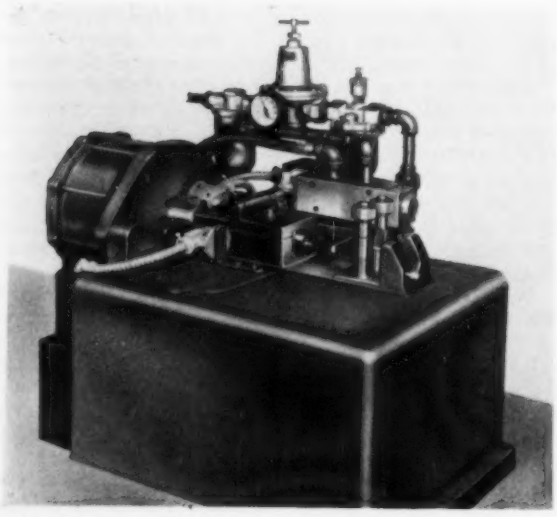
Now included in the range marketed by Funditor Ltd, 3 Woodbridge Street, London, E.C.1, are machines for performing various operations on the end of tubes. These machines are designed for the rapid production forming of beads, flares, flanges, threads, expansions and reductions of diameter, double lap flares and flanges and combinations of these shapes. Two types of machine are included: in the first, the forming tools have a sliding motion, and in the other, a rotary motion is employed to roll or spin the various shapes at, or near to, the ends of tubes. With both types, the tube is firmly clamped in a horizontal attitude while forming is taking place.

The range of machines is such that operations can be performed on tubing from $\frac{1}{8}$ in to 6 in diameter. Some are pneumatically operated, some hydraulically, and some mechanically; the smaller ones are bench mounted, the larger ones floor mounted.

In the illustration is the No. 6 machine for bench mounting. It is pneumatically operated, and accommodates $\frac{1}{8}$ in to 1 in diameter tube. This machine has a double sliding action, and is used for forming beads, single flares, double flares, flanges, and changes of diameter. It has a foot-operated control, as standard, depression of the pedal causing the clamp block to grip the tube. When the tube has been gripped, the forming tool advances, the tube is formed, the tool retracts and, finally, the clamp is released. Up to 1,000 operations per hour are possible with this unit which, when operated by air at 100 lb/in^2, imparts clamping and working loads of 7,800 lb each. The stroke of the clamp block is $\frac{3}{4}$ in, and that of the forming tool 2 in. A space 34 in long × 24 in wide × 32 in high is required for the machine, which has a weight of approximately 800 lb.

Above, right: Some examples of the wide range of shapes which can be rapidly produced at or near the ends of tubes by forming machines.

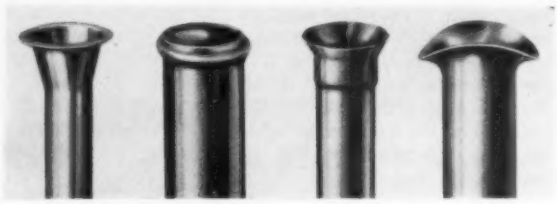
Below: This machine is a pneumatically operated one, for bench mounting. Tubes in the range $\frac{1}{8}$ in to 1 in can be accommodated on it
(Funditor Ltd.)



In addition to this wide range of standard machines, special purpose ones can be supplied to suit particular applications. All are characterized by rapid action and ease of tool changing, and some are completely automatic in operation. An indexing tool-holder can be added to most, so that two forming operations can be done for only one handling operation. One of the automatic machines has two work stations, and provision for magazine loading, and a production rate of 300 pieces per hour is claimed.

Magnetic chucks

Recently, the wide range of magnetic chucks and accessories that is produced by the Binder Magnete Co, of Germany, was introduced into British markets through the agency of Magco Ltd, Lake Works, Portchester, Hants. The range is loosely divided into four groups: fixed chucks for mounting directly to worktables; chucks with swivelling or adjustable movement; adaptor blocks; general accessories.



Rectangular chucks in the first group are in sizes up to 59 in × 19·7 in, and circular chucks in diameters up to 40 in. Different types of magnetic pole arrangements are incorporated in these chucks, according to the direction and weight of the cutting operation, and it is claimed that new developments in this respect have made it possible for much heavier cuts to be undertaken than were previously possible on components held by magnetic chucks. In the group of rectangular chucks there are three types of pole face: standard transverse pole; widely spaced longitudinal pole; narrowly spaced longitudinal pole.

The standard transverse arrangement is suitable for holding work of medium size, particularly if the component spans a centre pole and thus has two air gaps influencing the magnetic pull. For certain sizes, an edge-to-edge transverse pole division can be supplied, so that work can be held to the edge of the chuck or even on the side of it, for squaring up. Transverse disposition of the poles is desirable when heavy longitudinal cuts are to be taken.

Widely spaced longitudinal pole chucks each have a central pole and two outer poles, and are suitable for heavy work subjected to rotary machining operations. Narrowly spaced pole chucks are more suitable for small items uniformly distributed over the whole width; such items may be difficult to hold by any means other than magnetism, and milling and other relatively heavy machining operations can be carried out. In the group of circular chucks there are three types of pole arrangement: star, concentric, and parallel.

The swivelling chucks are in sizes up to 20 in × 8 in, and the chuck block, which is not clamped but grips the worktable by its own magnetism, is in one size only, 6·3 in × 2·9 in. Laminated adaptor blocks and plates are employed. They do not have an electrical supply of their own, but rest on chucks in order to afford support to components of complex shape. Among the accessories there are pole reversing switches, demagnetizers, and brush gears and slip ring units for application to lathes using magnetic chucks. All chucks are wound for standard voltages of 24, 110 and 220 d.c, and rectifiers are supplied by the manufacturers, as required.

Fig. 1. One of the bar shearing machines, viewed from the delivery end. The lengths sheared are held within close limits and are checked automatically by their weight

Bearing Race Production

By T. A. JAGEN*

Races for Tapered Roller Bearings Cold Forged in Pairs at a Rapid Rate

SO called chipless machining, involving cold flow of steel, usually with little or no scrap loss, is gaining slowly in importance because of the economies realized. Among major developments of this type is a method used by the Hyatt Bearing Division, General Motors plant in Clark, N.J, for the production of taper roller bearing races. One inner and one outer race are produced from each billet sheared from AISI No. 8620 steel bar stock, largely by cold forging in presses.

Hitherto, Hyatt made all races of this type from much more expensive steel tubing of the same analysis, the primary machining being done in bar type automatics. With this method of production, the proportion of metal machined away was relatively high. A major aim in developing the new method was the avoidance of this loss and, at the same time, reduction in cost by employing bar stock. Scrap is not eliminated but is greatly reduced because only light machining cuts are needed after forging. Most of the metal formerly converted into chips is saved by flowing metal into races the dimensions of which are quite close to finished size and shape. A small slug sheared to form a hole in the bottom of the inner race is the only scrap in forging. Although the number of operations required is greater than those needed with tubing, the extra processing is so highly mechanized that the increased labour costs are considerably less than the other savings realized. At present, only sizes produced in large quantities are made by the new method. This is because tooling and change-over costs for forging are high and long runs are necessary with forging set-ups if acceptable economy is to be attained. One outer and one inner race is made initially in a single piece, which, in the late stages of forging, is sheared to produce two separate races. This method involves the use of heavy presses but, as a pair of races results, the overall economy obtained is good.

Processing starts with the cutting of the billets from hot rolled bars, some of which are $1\frac{1}{4}$ in diameter. The bars are fed to shears, Fig. 1, automatically from inclined bar racks: each, after being fed to a stop, is clamped before each shearing operation. The cuts are made at a rate of about 35/min. Since the control of the weight of the billets is important, their lengths are held to close limits. An automatic weighing system is used, and chutes leading from the shear have gates that trip to discharge billets outside

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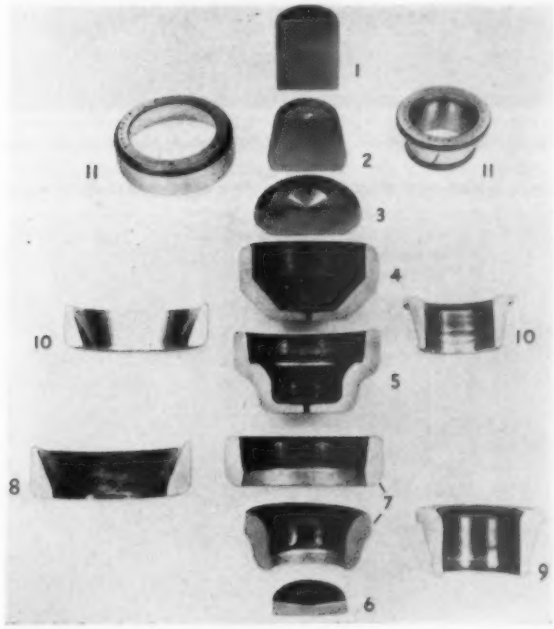


1 *billet;* **2** *preformed slug;* **3** *upset slug;* **4** *extrusion;* **5** *upset nose;* **6** *scrap;* **7** *nosed extrusion sheared into two separate races;* **8** *outer race coined;* **9** *inner race formed;* **10** *inner and outer races machined;* **11** *the finished inner and outer races*

Fig. 2. The billet and processed workpieces, sectioned to show the successive stages of production, and numbered in the sequence of operations; a pair of finished races is also included in the group

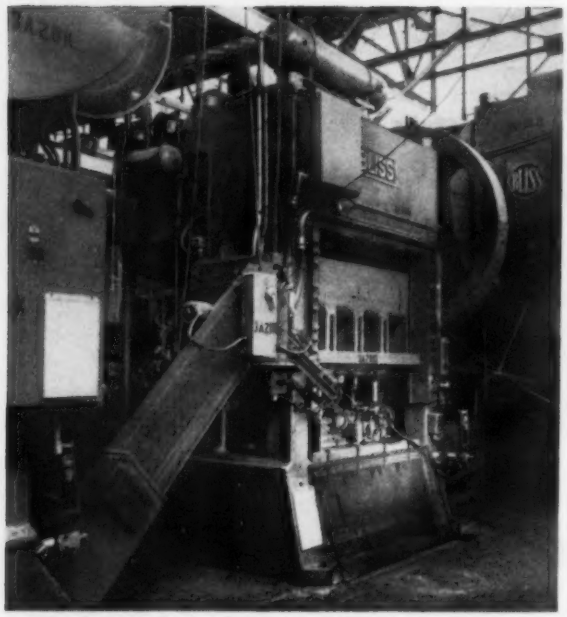


Fig. 3. This magazine-fed press noses, pierces and separates each forging into inner and outer races. Each is ejected into a separate chute and the slug into a third chute whence it is removed as scrap

weight limits and, in particular, the bar ends. Of the latter, those that are over-length are salvaged and the short ones scrapped.

In Fig. 2 are shown the forged parts, sectioned, after successive press operations and also two races after machining and grinding. All presses are continuously fed automatically with one piece at a time from magazines. Discharge to the mechanized handling system also is automatic.

In the first press, each billet—1 in Fig. 2—is fed on end by a slide from a track magazine, and is struck twice in successive positions. The first blow squares the piece to shape 2, and the second produces the biscuit or pancake, 3, suitable for cupping in the second press. In the latter, only cupping to shape 4, by backward extrusion, is done. Its die is fed by a slide that drops each cup into a conveyor. The third press, Figs. 3, 4 and 5, has three functions: first, a nosing strike produces the cup 5; the second blow, in another impression, pierces out the bottom slug, 6; and then the cup is sheared into two pieces, one the outer and the other the inner race, both marked 7 in Fig. 2. These two are discharged automatically into separate chutes leading to different conveyors. Because of work hardening induced by cold working in the first three presses, three separate annealing operations are necessary, one after discharge from each press, but the handling of the components is fully automatic. Finally, the components are passed to coining presses, in which the outer peripheries of the inner races are tapered, and the components lengthened, Figs. 6 and 7, and the outer races are tapered on their inner peripheries.

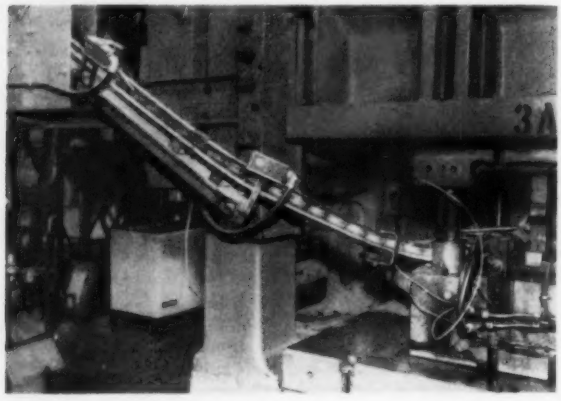


Fig. 4. Forged cups being fed to the die of the press shown in Fig. 3

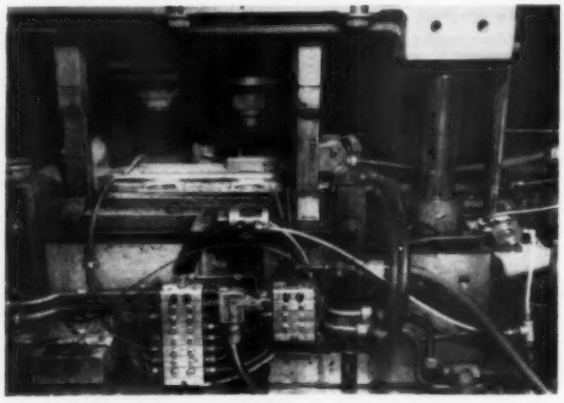


Fig. 5. Details of the die. The right-hand punch pierces out the slug

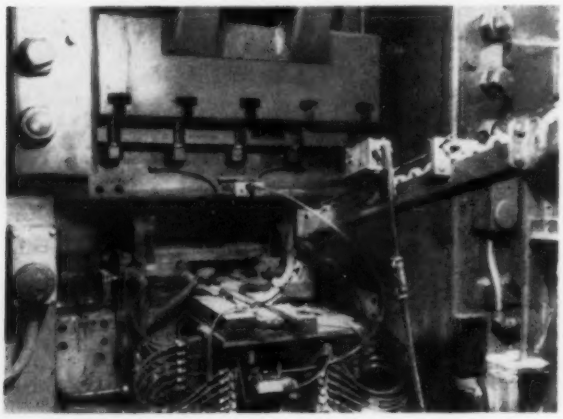


Fig. 6. Front of coining die, for inner races, with magazine on the right

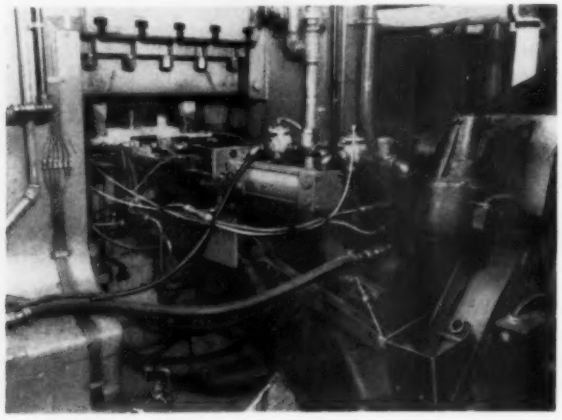


Fig. 7. Coined inner races drop into a chute and thence to the conveyor

The components are dropped into a chute and carried away by an elevating conveyor for delivery to the chucking automatics, which perform the subsequent machining operations.

Handling and treatment

As is well known, the advantages of cold forging are that the parts can be made more closely to the finished size, so material utilization is high and machining costs low. In addition, the complication of temperature control is obviated, scale formation does not raise serious problems, and die maintenance costs are therefore reduced. However, extra operations and equipment are required. Success and economy depend largely on the proper annealing of the metal, keeping it free from scale, and suitable chemical preparation to facilitate metal flow and minimize die wear. For these operations a relatively complex handling and treating system is used, but it is so well mechanized that only a minimum of labour is required.

Conveyors of different types effect all transfers from presses through treating equipment and back to large overhead hoppers from which workpieces are fed to the magazines that serve the presses. It is necessary to keep workpieces separated in the different stages of completion, but they all pass through one furnace, and through the same equipment for submersion in a series of tanks.

Accordingly, the furnace has four wire mesh conveyor belts, one for each type of workpiece handled. Two wide belts carry the pancaked and cupped forgings, and two narrower belts the inner and outer races which, of course, are kept separate. All parts attain a temperature of 1,400-1,425 deg F in the first furnace zone, in which they remain 45 min. Cooling to 1,100 deg F takes 30 min, in the second zone, and the workpieces remain at this temperature for another 30 min, before being discharged from the furnace. Cooling in air then occurs while the parts are moving on their way to the Wheelabrators.

There are four separate Wheelabrators, for mechanical cleaning, one for each line coming from the furnace, and discharging to the respective press feed lines. They are loaded from hoppers to a predetermined weight, controlled by sensing devices, before rotation and blasting take place. In each of these machines, steel shot is used for blasting the parts as they are tumbled in batches in the barrel of the machines. This removes all scale or discoloration resulting from heating the components in the furnace and subsequent cooling in air.

Parts discharged from the Wheelabrators are conveyed to bins, whence they are fed in batches, of like components, into perforated stainless steel barrels, Fig. 8. These barrels are on a loop conveyor that lowers each successively in a series of tanks for cleaning, phosphating and soap lubrication of the parts that it contains. The barrels rotate slowly when submerged in each solution or rinse, to ensure proper treatment of each forging and complete drainage before advancing to the next tank. During the cycle on this loop, the forgings pass in succession through alkali cleaner, cold rinse, sulphuric acid etch, cold rinse, hot rinse, zinc phosphate bath, hot rinse, neutralizing dip and metallic soap bath. Residual heat in the forgings dries the soap before the barrels are indexed to a turntable, which again is indexed automatically so that the appropriate type of forging always is directed to the correct station for discharge into a hopper for delivery to the press in which the next forging operation is to be done.

The combination of the zinc phosphate coating and the metallic soap on surfaces properly freed of oxide helps to promote metal flow in the forging dies and also to minimize die wear. Storage hoppers, between the treatment loop and the presses, have sufficient capacity to allow for changes in supply and demand. All feeds from hoppers through

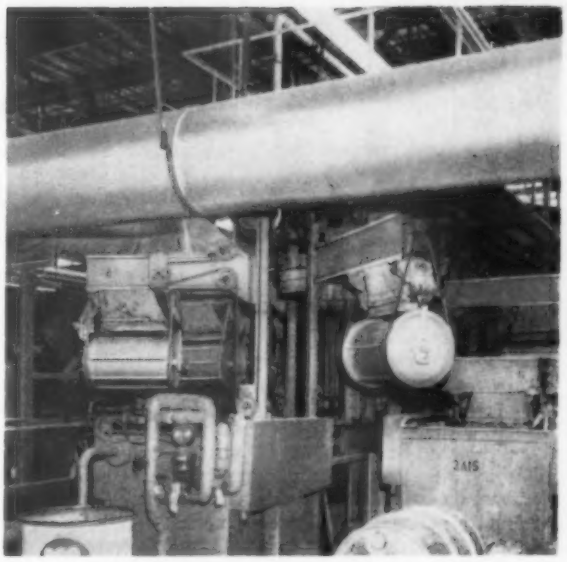


Fig. 8. After shot-blasting, the annealed forgings are placed in the perforated rotating barrels of this machine ready for phosphating

magazines to presses are started and stopped automatically with the presses.

After the inner and outer races are coined, they are fed to hoppers and loaded into magazines for automatic feed to two batteries of six-spindle chucking automatics, one for machining inner races and the other for outer races. High speed steel tools are used in these machines. Experiments with carbide tooling have shown that although faster cutting can be done with them, this necessitates running the machines at higher speeds, resulting in more down time and no net saving. For both races, the cuts are much lighter than those required in machining rings cut from tubing, and even when the material loss in the slug sheared from the inner race is added to the chip loss, the total is far below that for races machined from tubing.

Races discharged from the chucking automatics are fed automatically through washers and then to machines that stamp their end faces with identification letters and numerals. Then, after exacting inspection, they are placed in containers for hardening, followed by quenching in oil. All races, whether forged or cut from tubing, are ground in automatic set-ups that are the same for both types, close limits being held automatically. The conical surfaces of the races are then honed to extreme smoothness in special machines designed for this purpose by the Hyatt Division.

Data Recording

A SYSTEM for the remote indication and recording of data from conventional, process measuring instruments has been developed by Rotax Ltd. (Process Control Group), Chase Road, London, N.W.10. The basis of the system is analogue to digital conversion at the instrument shaft, without appreciable additional loading of the movement. A simple inexpensive unit can be fitted to, for example, pressure gauges, to convert them to digital transmitters. Data readings are recorded either automatically or manually, on demand, and either single readings or complete data logging can be obtained. Digital and control signals are transmitted along two wires only, and the power requirement is low enough to satisfy Post Office line regulations.

Lapping Automobile Components

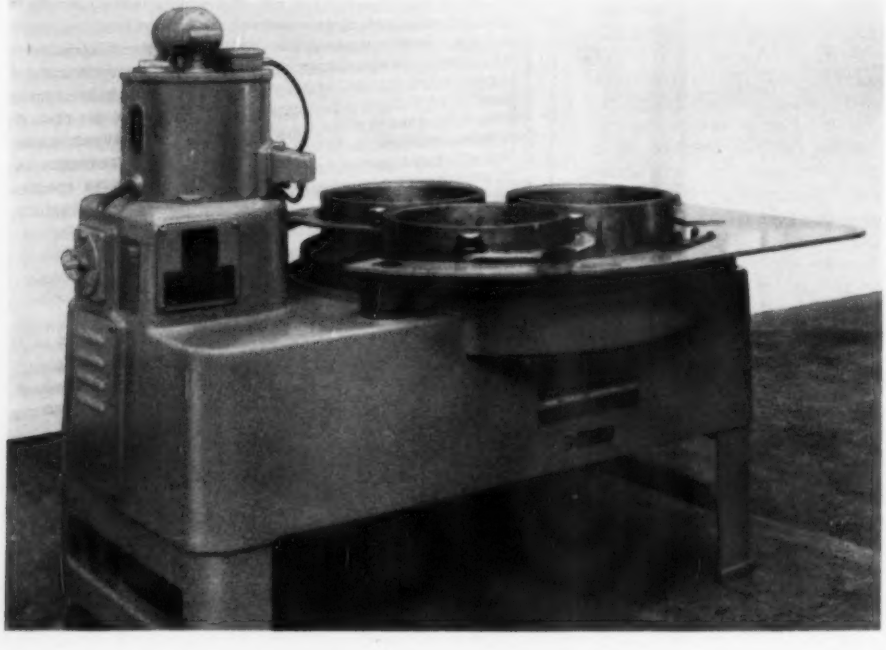
Application of the Lapping Process in Large-scale Production. Examples of the Use of Lapmaster Machines at the Vauxhall Plant. Current U.S. Practice on Light Alloy Cylinder Blocks and Heads

ON certain critical components, it is necessary to produce precisely flat surfaces and, in some instances, to combine this precision with a surface finish either superlatively smooth or of a controlled roughness or "texture". Over the years a method was sought of producing such parts rapidly, economically and, in particular, in large quantities. Manual methods such as hand scraping or hand lapping, demanding skilled labour, were too costly and too slow. Methods employing abrasive paper or tape, whether manually or mechanically operated, were not consistently successful. Precision grinding was long relied upon.

In the persistent effort to improve the performance and reliability of components, no less than in the urge to speed production and reduce manufacturing costs, recent research has indicated that under certain conditions the grinding method is not always satisfactory. On highly stressed surfaces subjected to rubbing, sliding, or impacting motion —tappets, valve ends, seals, and thrust washers, for example —it has been found that minute surface imperfections formed in grinding can be a cause of eventual damage to a contacting or mating part. Furthermore, where the contacting parts have a wiping action, as in the case of a valve cam and tappet, a smoothly ground surface may not be capable of retaining lubricant and a failure may result from lack of lubrication.

Lapping has been found to offer a solution to such problems, and modern lapping machines can process components with rapidity in the quantities required at economical rates. "Lapmaster" flat-type lapping machines were originally designed and developed by Crane Packing Co. of Illinois, U.S.A, for the specific purpose of producing mechanical shaft seals for its own use. The requirements it had to meet were components in a varied range of materials and sizes processed to a flatness of better than one light band and having a surface finish of from two to three micro-inch, c.l.a. After the company had used these machines in various sizes over a period of fourteen years in the manufacture of its own products, it was decided to market them, and a separate company, Payne Products International Ltd, of Buckingham Avenue, Trading Estate, Slough, Buckinghamshire, was formed to handle all British and European manufacture and sales. There are also branch factories of the British company at Huddersfield and East Kilbride, Glasgow. At each of the three factories, the precision lapping of components in any metal, ceramic, carbon, or other material is undertaken on contract. On metal parts having a diameter up to 6 in, flatness to less than one light band, 0·0000116 in, and surface finishes from 2 to 3 micro-inch, c.l.a, can be produced consistently as a regular service to industry.

Lapmaster machines are built in a range of six sizes having lap plates of from 12 in to 84 in diameter. The largest machine can handle components up to 33 in diameter. It should be noted that small parts that can be processed on the smallest machine at a high production rate can be equally well lapped on the larger machines should it be desired to increase the volume of production. All machines embody the same design principles and are basically similar in construction, with the exception of the 12 in model, which is arranged for bench mounting. Every machine, according to



The current 36 in Lapmaster machine equipped with three conditioning rings. This is one of the range of models manufactured in Britain

size, has three or four "conditioning" rings which serve as work retainers and, consequently, three or four different components can be lapped simultaneously to the same high quality finish if so desired. Little operating skill is required and operators can be quickly trained to produce work of consistent quality.

A 36 in machine illustrated is typical of the range. The horizontal lap plate is carried on a vertical shaft running on taper roller bearings in a rigid mounting in the cast base. Resting on the lap plate are three conditioning rings, each positioned with freedom to rotate by a roller-ended, forked member. Parts to be processed are seated on the lap plate and retained by the conditioning ring, also with freedom of movement. Over the parts is placed a felt pad to compensate for any slight variation in height and load is applied by the dead weight of a pressure plate. Lapping abrasive, held in suspension in a suitable liquid medium in a machine-mounted tank furnished with a motor-driven agitator, is fed under control down a track to the side of one of the conditioning rings. From this ring the abrasive is evenly distributed across the face of the lap plate. Radial slots in the lap plate surface collect and discharge to the periphery by centrifugal force the spent abrasive compound and the removed stock material.

In operation, the lap plate is subjected to wear from the parts being processed, of course, but simultaneously the retaining rings, imposing a greater load on the entire face of the lap plate, are continually and automatically conditioning it. Hence the designation "conditioning" rings. Wear is distributed evenly and the overall surface flatness of the plate remains unaffected. Only after very long periods of service is it necessary to replace a worn lap plate.

Operation of the machine on automatic cycle is simple. With the agitation tank charged with abrasive and carrier in specified proportions, and the machine loaded with workpieces, the sequence is as follows:

(1) Switch on agitator motor

(2) Turn on compound valve switch

(3) Set timing clock to specified time cycle.

This last action automatically starts the rotation of the lap plate and opens a solenoid-operated valve, allowing compound to flow down to the conditioning ring. At the end of the lapping cycle the timing clock automatically closes the solenoid valve and stops rotation. After unloading and reloading, the machine is started on a repeat cycle by merely resetting the clock.

To obtain a specific surface finish on the work, careful selection must be made of both the abrasive compound and the vehicle. Drawing on experience extending over 24 years, the builders of the Lapmaster machines have developed abrasive media ranging from the coarsest, for heavy stock removal, to the finest for optical components. Hand-lapping compounds are supplied suspended in the vehicle but for Lapmaster machines, compound and vehicle are furnished separately to enable precise control to be exercised. Granular size of the abrasive is meticulously controlled in order to ensure consistently accurate surface finish on the work.

In use, the correct proportions of abrasive compound and vehicle are mixed in the agitation tank on the machine. The actual cutting of the work surface is performed by the compound and its action is controlled by the viscosity of the medium in which it is suspended. Two commonly used abrasives are aluminium oxide for fine finishes and silicon carbide for faster stock removal. Five grades of aluminium oxide can, selectively, give surface finishes of from 2-4 micro-inch to 5-8 micro-inch, while four grades of silicon carbide produce surfaces of from 5-10 micro-inch to 30-40 micro-inch. One standard vehicle, defined as No. 3 vehicle, is used with all abrasives with the sole exception of the very coarsest silicon carbide, for which a special vehicle, No. 4,

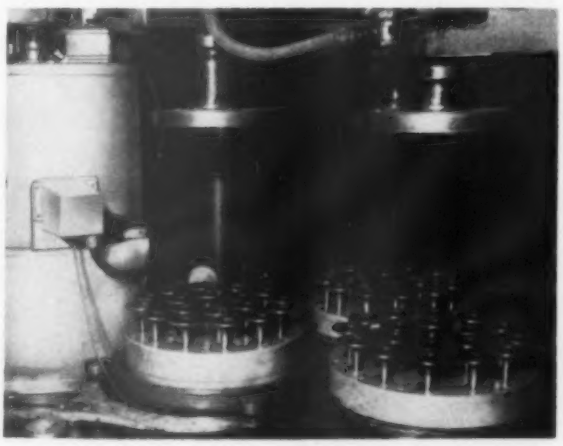
A 24 in model Lapmaster in a Vauxhall productions line, lapping the ends of engine valve stems to precision flatness and surface finish

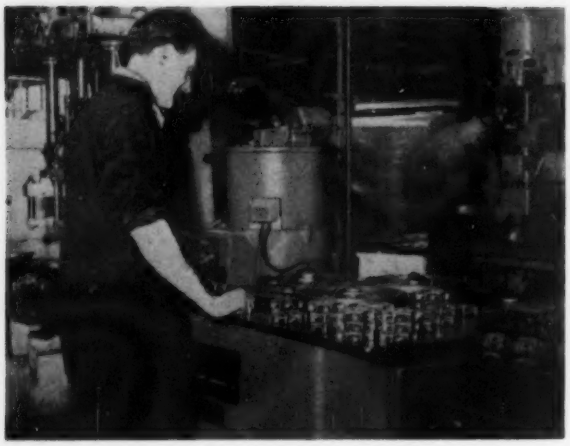
is available. Should the machine be used for lapping carbon or other extremely porous materials that could be contaminated by an oil-base vehicle, a water-base vehicle, designated GL 3, is recommended.

As stated earlier, the 84 in machine can accept a component up to 33 in diameter in each of its four conditioning rings. The 36 in machine illustrated can accommodate work up to $12\frac{3}{8}$ in diameter in four rings or up to $14\frac{1}{2}$ in diameter in three rings. To process workpieces of a larger size than can be accommodated in the conditioning rings of any machine, use is made of a so-called spider bar. This is a slotted bar, supported horizontally above the lap plate on two columns that are adjustable for height. On this bar is secured at right angles a slotted cross bar. Two or three conditioning rings are removed, allowing the workpieces to be seated directly on the lap plate. A simple fixture, seated either in or on each workpiece, is provided with a vertical drilling in which is engaged a pivot pin slidably mounted in a bushing secured in an adjusted position in one of the slotted bars. One ring must be retained to receive and distribute the lapping compound and also to maintain the routine conditioning of the lap plate.

Other auxiliary equipment is available to facilitate operations and to extend the scope of application. Illustrations

The machine laps 54 valve ends simultaneously. Pressure plates are raised by pneumatic cylinders to facilitate loading and unloading





Lapping the rear faces of 24 water pump impellers. Left, the machine in operation. Right, removal of pressure plates ready for unloading

of 24 in machines at the Vauxhall plant show the provision of pneumatic lift cylinders to raise and lower pressure plates and conditioning rings. These lifts can effect a substantial reduction of loading and unloading times and, in this respect, are particularly valuable when large numbers of relatively small parts are to be lapped. In certain instances, production rates have been doubled by their use.

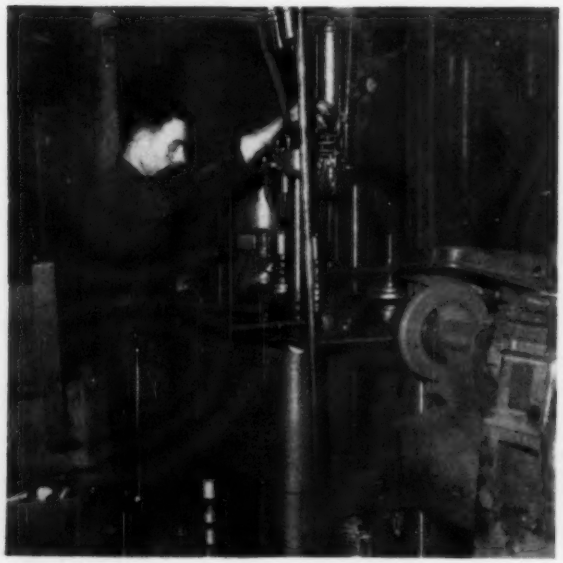
For lapping the faces on shouldered work a special lap plate having deep concentric grooves is fitted. Simple brass workholders provide the necessary weight and stability, and roller guides retain the work in position with freedom of movement. Conditioning rings are positioned on pivot pins from a solid spider frame and are spring loaded to ensure elimination of the effects of localized wear of the lap plate surfaces.

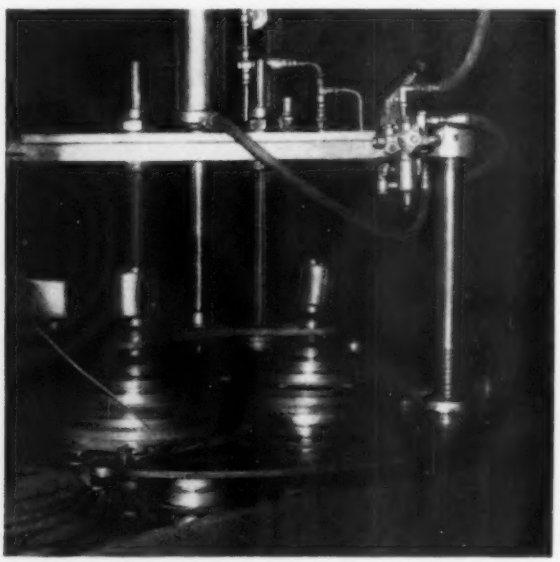
Inspection and checking of surfaces after lapping is best accomplished by light-band readings through an optical flat, using a monochromatic light source. Suitable apparatus and all necessary accessory equipment is supplied by the manufacturer of Lapmaster machines. The light is a self-contained unit in a case, measuring 12 in × 13 in × 11 in high, which includes storage space for 5 ft of extension lead for connection to a power source and also for optical flats.

The helium gas-filled tubular light source is recessed the cover of the unit and provides more than 25 foot-candles illumination on the test surface. Light transmitted through a flashed opal diffusing glass eliminates all colours except a "yellowish-orange" having a wavelength of 23·2 millionths of an inch. Only half a wavelength, the dark interference band, is used in the measurement procedure. These dark bands are not light-waves, but merely show where interference is produced by reflections from two surfaces.

Power feed for the light source is by a 6,000 V transformer which can operate on either 110 V or 220 V, 50-60 cycle, single-phase, A.C. supply. Changeover from one voltage to another is simply effected by moving a busbar from one terminal to an alternative. The light transmits little heat, yet its power is sufficiently strong to reflect light-bands through a wide range of air-wedge thicknesses between the surface of the work under inspection and the optical flat.

Left, here 183 valve tappets are lapped on the face to better than 10 micro-in c.l.a. Right, one pneumatic cylinder lifts all pressure plates





Lapmaster optical flats are available in highly transparent, fused silica which holds its shape indefinitely and resists abrasion and thermal shock. Produced in seven sizes, 2, 3, 4, 6, 8, 10, and 12 in diameter, they are double-faced to avoid inadvertent error—by the use of the wrong side in a single-faced flat—and to extend the useful working life before reconditioning becomes necessary. Each of the seven sizes of flats can be supplied with alternative surface accuracies of $\frac{1}{4}$ or $\frac{1}{10}$ of a light band across its diameter. A less expensive range of flats, finished to the same degree of accuracy, is available in Pyrex glass.

To obtain maximum reflectivity from a lapped surface for the purpose of light-band interpretation it is usually desirable to lightly hand polish the work. Polishing plates, specially suitable for relatively soft materials, and polishing stands carrying a roll of fine grade polishing paper for hard materials are supplied by the company.

Practice at Vauxhall Motors Ltd.

At both their Luton and Dunstable factories, Vauxhall Motors rely implicitly on 24 in Lapmaster machines to finish highly critical components to exacting finishes. At Luton, over 50 valves at one time are placed in the Lapmaster's three conditioning rings to receive their required measure of precision flatness. The rotary action of the lap plate smooths and squares the hardened ends of the valve stems in a cycle time of two minutes only.

Research at Vauxhall showed that if parts such as tappets were ground, there was a possibility of the minute surface finish imperfections which were formed eventually damaging the cam contours. Lapping, however, produced a surface finish of extreme smoothness and flatness, and obviated that hazard. Another Lapmaster machine is employed, therefore, to produce on the base of the tappet a surface finish of between 5 and 10 micro-inch. The machine handles a full load of 183 tappets in the three conditioning rings and after an operating cycle of 7 min they are ready for removal for washing and degreasing.

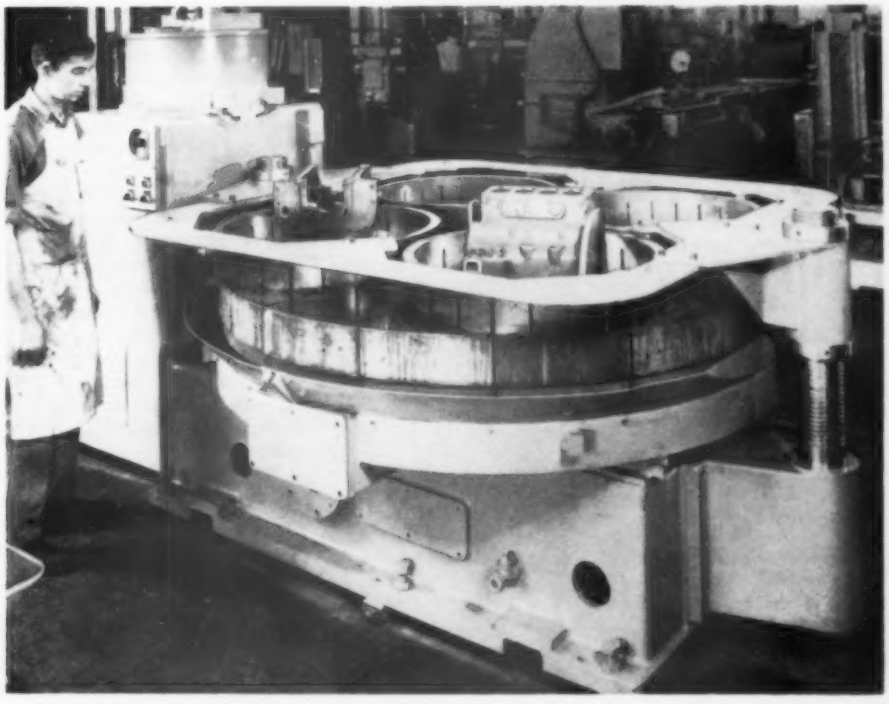
A further lapping operation at Vauxhall relates to the precision finish of water pump impellers. To ensure that the face of the rotor seats satisfactorily in the pump housing to form an essential water seal, it is lapped to a surface finish of 10 micro-inch c.l.a. The rotor castings are only turned prior to lapping, illustrating the machine's capacity to eliminate intermediate operations.

Lapping aluminium components

A recent trend in the American automobile industry is for "compact" cars to be fitted with engines having aluminium cylinder blocks and cylinder heads. One unusual feature of these American units is that no gaskets are used. The aluminium joint faces are lapped to a high degree of surface finish and flatness and bolted together directly. Manufacturing practice is to employ Lapmaster machines at the beginning and the end of the machining cycle. Most cast components need a reference face for subsequent machining operations; they need only be placed on a Lapmaster machine to produce this datum. After machining, the castings are again lapped on Lapmaster machines in order to obtain a high-quality, precision finish.

Distortion often occurs as a consequence of conventional machine clamping methods. An aluminium casting has a tendency to return to its original shape once the clamps have been released. With the Lapmaster machine, however, no clamping is required as the component is lapped in a free state without any applied external force other than that of the pressure plate weight. Light alloys are notoriously difficult to grind. Abrasive wheels or belts rapidly become "loaded" with removed stock and, thereafter, the work surface is likely to be gouged, or deeply scratched. Lapping presents no such hazards and continuously produces accurate, scratch-free surface finish. Stock removal can be rapid.

An incidental advantage of lapping is that no burrs are produced on the marginal edges of the work face, or on the edges of an interrupted surface. This is of particular value on such items as cylinder heads and on the fluid-circuit "sandwich" plates of automatic transmission units, eliminating the need for time-wasting and expensive deburring



American-built 72 in machine with roller bar attachment, lapping four-cylinder engine blocks on head and sump faces. Mating with a similar lapped face on the cylinder head, no gasket is required

operations. The last mentioned items are finished to 2-3 micro-inch, to a flatness of one light band, and to exacting tolerances for parallelism. Mating surfaces (not selectively assembled) need no gaskets and are fluid-tight to pressure in excess of 200 lb/in^2.

Surface finish measurement

The builders of the Lapmaster machines use and recommend an instrument of Swiss manufacture, the Diavite Microtester, for the examination and measurement of surface finish. It is robustly constructed as a workshop instrument, but its high accuracy and repeatability of readings make it suitable also for laboratory use. The current version of the instrument—Payne Products International Ltd. are the sole British agents—provides direct meter readings, by push-button selection, in three different values. These are (1) R_a—centre line average (c.l.a); (2) R_p—maximum height of profile above mean centre line; and (3) R_{max}—maximum depth of profile from peak to valley.

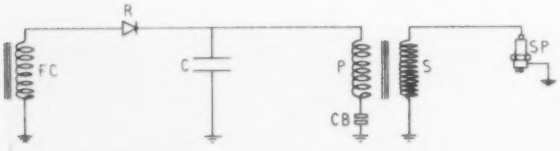
Although British Standard No. 1134:1950 stipulates the use of the centre line average (c.l.a) system, the ability to determine the R_{max} value is of considerable interest when it is desired to investigate machining characteristics of material or the surface damage of worn components. Various types of tracer head are available for measuring different classes of work and the standard, hydraulically operated, stylus stroke length is 4 mm. Other stroke lengths, between 1 mm and 12 mm, can be provided to order. Stylus nose radius may be 2·5, 5·0, or 7·5μ. Pen recording equipment is available if permanent records of surfaces should be required.

Magister Ignition System

Development by Wipac, which has Interesting Potentialities for Both Two- and Four-Stroke Engines

AN ignition system claimed to solve the common problem of the difficulty of starting two-stroke engines has been developed by Wipac Group Sales Ltd. It is possible also that adoption of the Magister system, as it is called, might facilitate further development of four-stroke engines. For example, higher compression ratios might be employed, and on an engine having a low compression ratio, the system has already been used for multi-fuel operation.

The essential basic component of the system is a condenser, which is charged through a rectifier by a feed coil. When the condenser is charged, and at the appropriate moment in the engine cycle, the contact breaker points close to enable the discharge to take place through the primary winding of a coil; the high voltage output from the secondary winding is taken to the spark plug in the usual manner.



FC *feed coil*; **R** *rectifier*; **C** *condenser*; **CB** *contact breaker*; **P** *primary winding*; **S** *secondary winding*; **SP** *sparking plug*

Above is the circuit diagram of the Magister ignition system, and below is an illustration of the components, together with an engine flywheel

It is the production of the spark on the closing, instead of the opening, of the contact points that is the principal advantage of the system. This advantage arises because the spark occurs over an appreciably shorter space of time than it does in the conventional system, in which a certain amount of arcing at the points as they open is inevitable. By virtue of the shortening of the duration of the spark, the rate of transmission of energy is greater and ignition of the petrol-air mixture more effectively initiated. Experiments with a wide variety of engines have shown that, because of the rapid initial rate of burning of the mixture, it is necessary to retard the ignition timing by about 3 or 4 deg in order to obtain the same optimum b.h.p. from the engine.

In demonstrations on a two-stroke engine designed to operate with a petrol:oil ratio of 24:1, it was shown that with the Magister ignition system it is possible both to start easily and run the unit with a 4:1 mixture. In another test, a two-stroke engine, operating on the correct mixture of petrol and oil, was run while a jet of clean water was directed over the sparking plug insulator. This engine was stopped and started again with the water jet still directed on the plug. Then oil was squirted from a syringe into the air intake of the engine, while running, until it was dripping out of the exhaust. The engine was stopped, and then started again easily. Next, the spark plug, which was in new condition, was taken out and was found to be covered with a film of oil. Before it was replaced, the cavity between the centre electrode and the surrounding portion of the body was filled with some clean lubricating oil, but despite this, the engine started again without any difficulty. In another demonstration, oil was poured from a syringe over the contact breaker points while the engine was running, and then handfuls of dust were thrown directly on to the points. In each of these conditions, the engine was run fast and slowly, and stopped and re-started again without any difficulty.

While the advantages of the system are not so pronounced for four-stroke engines, there are significant possibilities. For example, an engine having a low compression ratio was demonstrated first on petrol, then on TVO and, finally, on diesel oil. With the latter two fuels, the engine will start only after it has been warmed up by running it on petrol. Throughout all the test work, no plug whiskering has been experienced. It will be interesting, therefore, to see whether further development work shows that this problem is indeed overcome now by the use of the Magister ignition system.

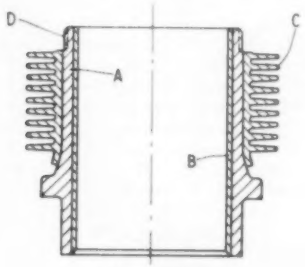
CURRENT PATENTS

SELECTED ABSTRACTS OF RECENTLY ISSUED SPECIFICATIONS

Composite engine cylinders

THIS invention deals simply with a cylinder barrel, which consists of a steel cylinder A, inside which is a cast-iron liner B, and outside which is a finned sleeve C of aluminium. This composite assembly, intended primarily for use in an internal combustion engine, combines the strength of the steel cylinder with the resistance to wear and the oil retention properties of cast iron, together with the high thermal conductivity of aluminium. In addition to this, if it is desired to screw the cylinder into a cylinder head or crankcase, the screwed portion D is stronger if cut in the steel than it would be in either cast iron or aluminium.

The liner B is a centrifugally cast component, and its thickness can be from



No. 860899

1 to 3 mm. No other dimensions are given, but provision is made for the Alfin process to be used in the fitting of the finned sleeve to the cylinder. *Patent No.* 860899. *Daimler-Benz A.G.* (*Germany*).

Treating ferrous metal surfaces

A METHOD of alloying or hardening the surface of a ferrous metal is described, the object of this treatment being the local improvement of cutting properties, hardness, and self-lubricating characteristics. The surface to be treated is submerged in a liquid, and an electrode in close proximity to the surface is made to produce a spark discharge and so cause localized heating. This process, assisted by the presence of an alloying metal, leads to the formation of a layer of hard alloy or compound on the surface of the workpiece. According to the intended composition of the layer, this alloying metal may be previously incorporated in the material of the electrode, or it may be in the form of particles suspended in the liquid. To assist the process, the electrode is made to vibrate axially while discharging sparks.

Several examples of materials suitable for various applications of the process are set out in the specification. For one system, for the formation of a hard titanium carbide surface, titanium is specified as the electrode and mineral oil as the liquid, which serves to prevent oxidation; in another example, the liquid comprises a solution of ammonia, so that a nitrogen compound is formed; and in yet another the liquid contains sulphur, so that a metallic sulphide is produced. *Patent No.* 860563, taken out by the same company, deals with a process basically similar to the one in this specification, but applicable to non-ferrous metals. *Patent No.* 860562. *Associated Electrical Industries Ltd.*

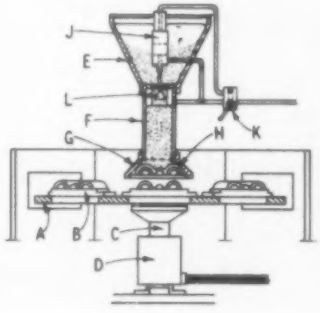
Collapsible steering column

MORE and more thought is being given during the design stage to the provision of safety features in vehicles. This specification is for a steering column that will telescope when a driver is precipitated forward during a head-on collision. Incorporated in the column is a damping device to make the telescoping a gradual movement rather than a sudden one.

The steering column comprises two main components; the upper one A, to which the steering wheel is attached, is splined over a portion B of its length and, therefore, can slide in the lower component C. A universal joint G, at the lower end of C, transmits angular movements of the steering wheel to steering box H; fixed to a shoulder on the outer surface of C is the lower end of the thin wall tube K that encloses the column and acts as a reservoir for the oil F that is used in the damping system. At the upper end of the tube is the oil seal J which bears on column A, and just above it is a device that locates the column axially during normal driving conditions but allows it to collapse under an excessive end loading.

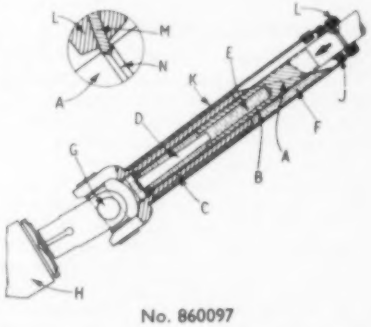
This device consists of a split conical washer M, set in a rubber ring L, and registering in an annular groove N in column A. Ring L is mounted in tube K, and the washer M is so positioned that it acts as a circular pawl and prevents upward movement of the column. The

No. 860646



load needed to cause downward movement is determined by the hardness of rubber ring L.

Finally, the other device, that for damping the telescoping action, is at the lower end of the column; it consists of a tapered



No. 860097

spigot D, fixed in the end of the splined hole in C and pointing upwards, which registers in a deeply drilled axial hole in A. When the column is telescoped, a dashpot effect is afforded by the taper of the spigot as it enters the hole. Oil that is displaced during this stage is allowed to pass into the annular reservoir through either a small radial hole or a passage afforded by the omission of one of the splines. *Patent No.* 860097. *Daimler Benz A.G.* (*Germany*).

Automatic core moulding

TRADITIONALLY, there is a great deal of manual work involved in the manufacture of sand cores for casting operations. A fully automatic system of moulding and baking these cores is described, in which the cores are carried through an oven after they have been formed under the pressure from a pneumatic ram. A rotating table A carries a number of identical moulding plates B equally spaced around it, on each of which is a mould corresponding to the shape of one side of the core.

The other mould H is contained in a static pouring head G that is at the lower end of a vertical funnel F, which at its upper end incorporates a hopper E for loading the sand, and a ram L for applying the moulding pressure. Sand from the hopper is allowed to fall on to a grating above mould H, and the mesh of the grating is such that the sand will not pass through it unless pressure is applied by the ram. This ram is at the upper end of the funnel F and is operated by a vertical, double-acting, pneumatic cylinder J in the centre of the hopper; control is effected by means of a two-way valve K.

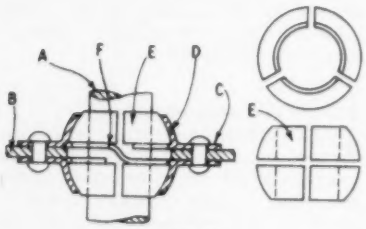
When moulding is to take place, the moulding plate that is at the loading

position is lifted from the revolving table by a plunger C operated by a pneumatic cylinder D beneath the table. The plunger passes through a hole in the table and holds the moulding plate in position while the ram L forces sand into the moulds. When the plunger has lowered the plate on to the table again, the table moves on, so that the next moulding can be made while previous ones are passing through the furnace, which surrounds part of the path traversed by the table. *Patent No.* 860646. *Volkwagenwerk GmbH (Germany).*

Self-adjusting spindle bearing

A BEARING as described in this specification is suitable for use in the linkage of a steering-column gear change mechanism, since the requirement is for sliding, rotating and angular movements. A spherical component E is bored to a diameter such that it is a sliding fit on a shaft, and is divided radially, relative to the axis of the shaft, into two or three equal sectors; each of these sectors is then divided into equal halves on a plane at 90 deg to the axis. In the construction of the bearing, a spring washer F, exerting an axial force, is inserted between the faces formed by this last cutting operation.

Assuming that the shaft A is to pass through a hole in a flat plate B, the portions of the spherical component E are enclosed by two cup shape pressings C that are riveted one on each side of the plate. These pressings have holes through



No. 860774

them which are sufficiently large to allow clearance for the shaft to have the required degree of angular movement. The spherical component can be of sintered material, and impregnated with oil if desired.

This bearing is, to a certain degree self-adjusting, since any angular looseness will be taken up by the action of the spring. If the material of E is soft enough, longitudinal and rotational wear will also be taken up by the wedging effect of cups D. *Patent No.* 860774. *Humber Ltd.*

Diecast split cylinder block

CONVENTIONAL methods of diecasting cylinder blocks tend to be expensive because of the subsequent machining operations involved. If the cylinder block and crankcase are made from two castings joined at the vertical plane of the cylinder axes, the oil galleries can be cast into the joint face, and some of the machining is thereby obviated. This patent is for such an arrangement, which is also of interest in that the two castings are extended longitudinally to form a housing for the clutch and gearbox.

The engine is an air-cooled unit having wet cylinder liners: this apparent anomaly arises from the provision of helical grooves, in the block around the liners, through which oil flows to afford an extra degree of cooling. In the sectional illustration of the engine and the gearbox housing, there are four in-line cylinder bores A, in one of which is shown a liner B. Below them is crankcase C, and to the rear of this is the flywheel housing E, and behind this again is the gearbox F.

A continuous groove K for a resilient sealing strip is cast into the jointing face, which is drawn in hatched lines, and the bolts which hold the two castings together pass through holes J. The gallery L feeds oil to main bearing housings D, and also to the mainshaft and layshaft bearing housings, H and G, in the gearbox; oil is is also carried through channels to helical grooves M in the cylinder walls.

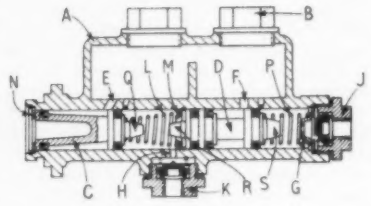
Several other aspects of this type of cylinder block construction are covered by patents Nos. 858594 and 858595. *Patent No.* 858593. *Engineering Research and Application.*

Dual hydraulic master cylinder

IN the interests of safety, some vehicles are fitted with dual braking systems, having one line for the front brakes and one for the rear, with a separate master cylinder and reservoir for each line. This patent specification describes a master cylinder which serves two separate brake lines but is designed to continue operating when one of them fails, such an arrangement being one that has the virtue of low cost and simplicity. The reservoir is above the master cylinder, and both are in a single casting A, on top of which are two filler caps B.

A long bore of uniform diameter contains an actuating piston C and a floating piston D; C is operated by the push rod that is connected to the brake pedal, and, in moving, displaces a column of hydraulic fluid that in turn operates the floating piston. Between the two pistons is the outlet to one of the brake lines, and at the end of the cylinder, beyond the floating one, is that for the other. Axial motion of the pistons, when the brakes are released, is limited by two circlips in grooves in the bore of the cylinder, one at the push rod end and one at the centre, and by the pipe union at the second outlet.

A coil spring in compression L holds piston C against a ring N, which abuts against the end circlip; the other end of this spring bears against a ring M, which is retained by the central circlip. Piston D is held, by a coil spring P, against the other side of the central circlip, and this



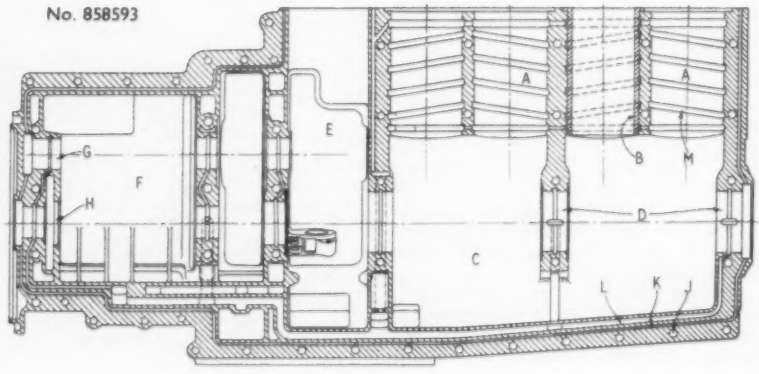
No. 860739

spring abuts against a dished washer G, which is retained by the outlet union J. Beneath the central outlet hole H there is the other pipe union K, and both of the unions incorporate recuperation valves.

When the brake pedal is depressed, the initial movement of piston C covers the small feeder hole from the reservoir to the cylinder, and builds up a pressure between the pistons and in the line connected to the central outlet. The resultant movement of piston D covers up its own feeder hole and increases the pressure in the other line. Close to each of the feeder holes E and F, and on the push rod side of it, there is a larger hole which allows the fluid to return rapidly to the reservoir in the event of a sudden relaxation of pedal effort.

Should there be a failure or leak in the line that is served by the central outlet, pedal movement is transmitted to the floating piston when a protrusion Q on piston C contacts protrusion R on piston D; similarly, in the event of failure in the other line, protrusion S on the other end of piston D contacts the dished washer G and is prevented from moving further. Hence, failure in either line will cause an increase in pedal travel, but not complete loss of braking. *Patent No.* 860739 *Kugelfischer Georg Schäfer (Germany).*

No. 858593



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** These times are based on 'The Handbook of Standard Time Data for Machine Shops' by Haddon & Genger published by Thames and Hudson Limited, London.*

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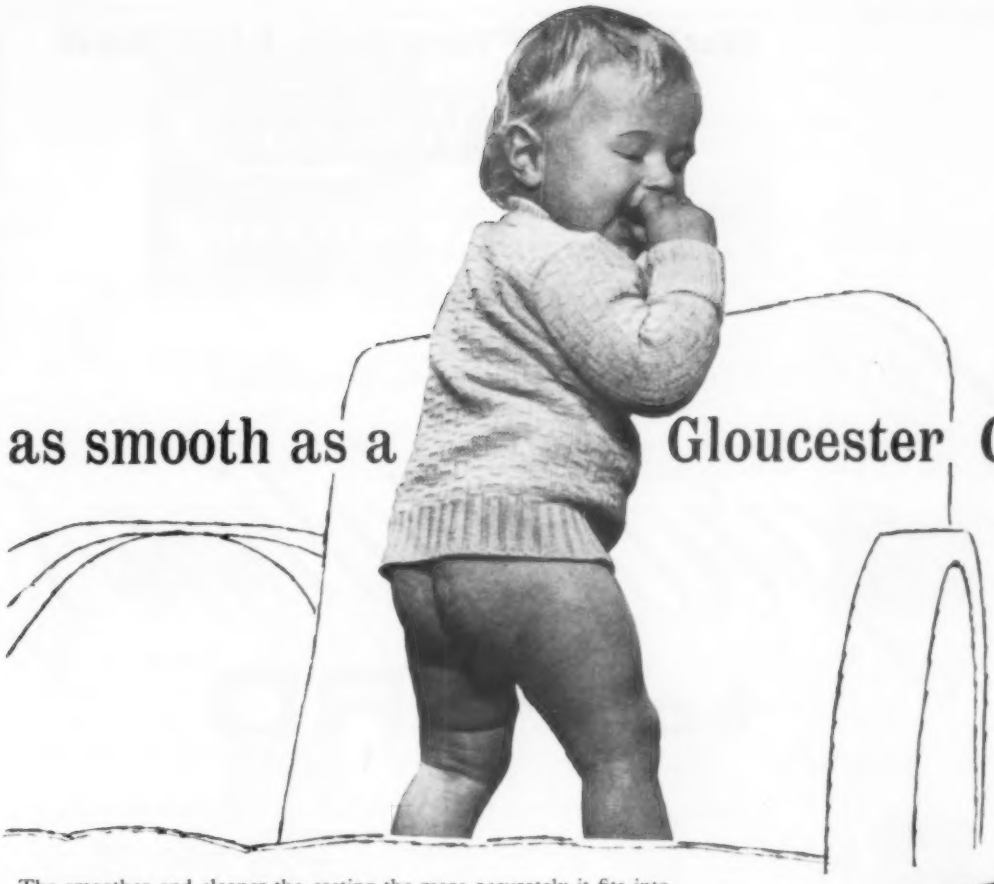

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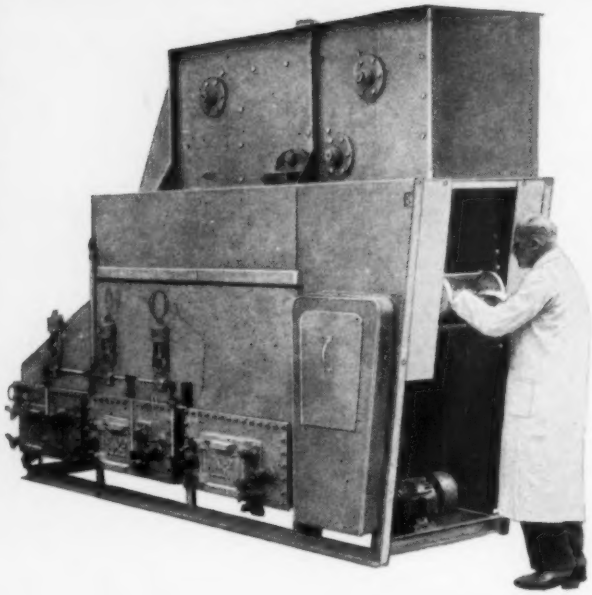

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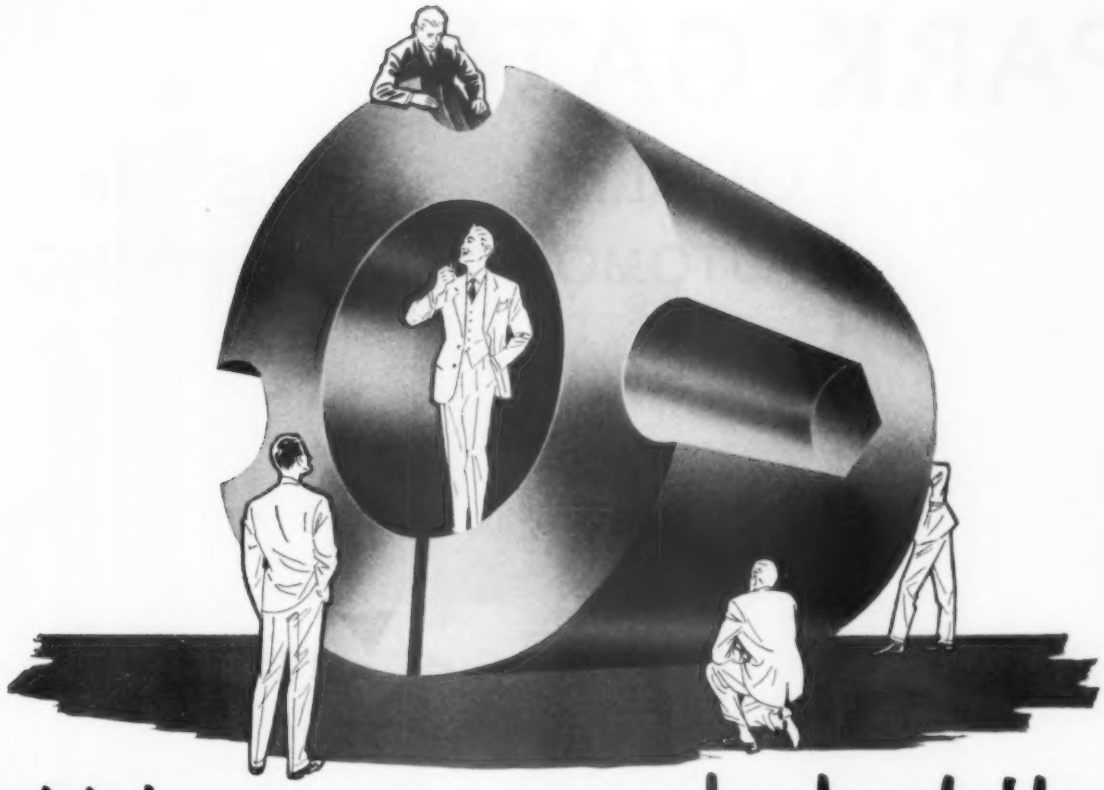

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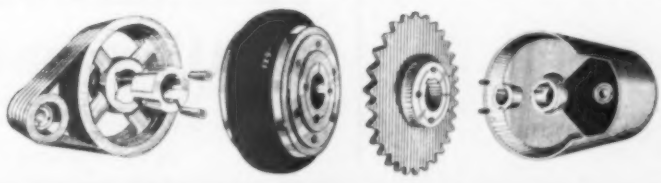

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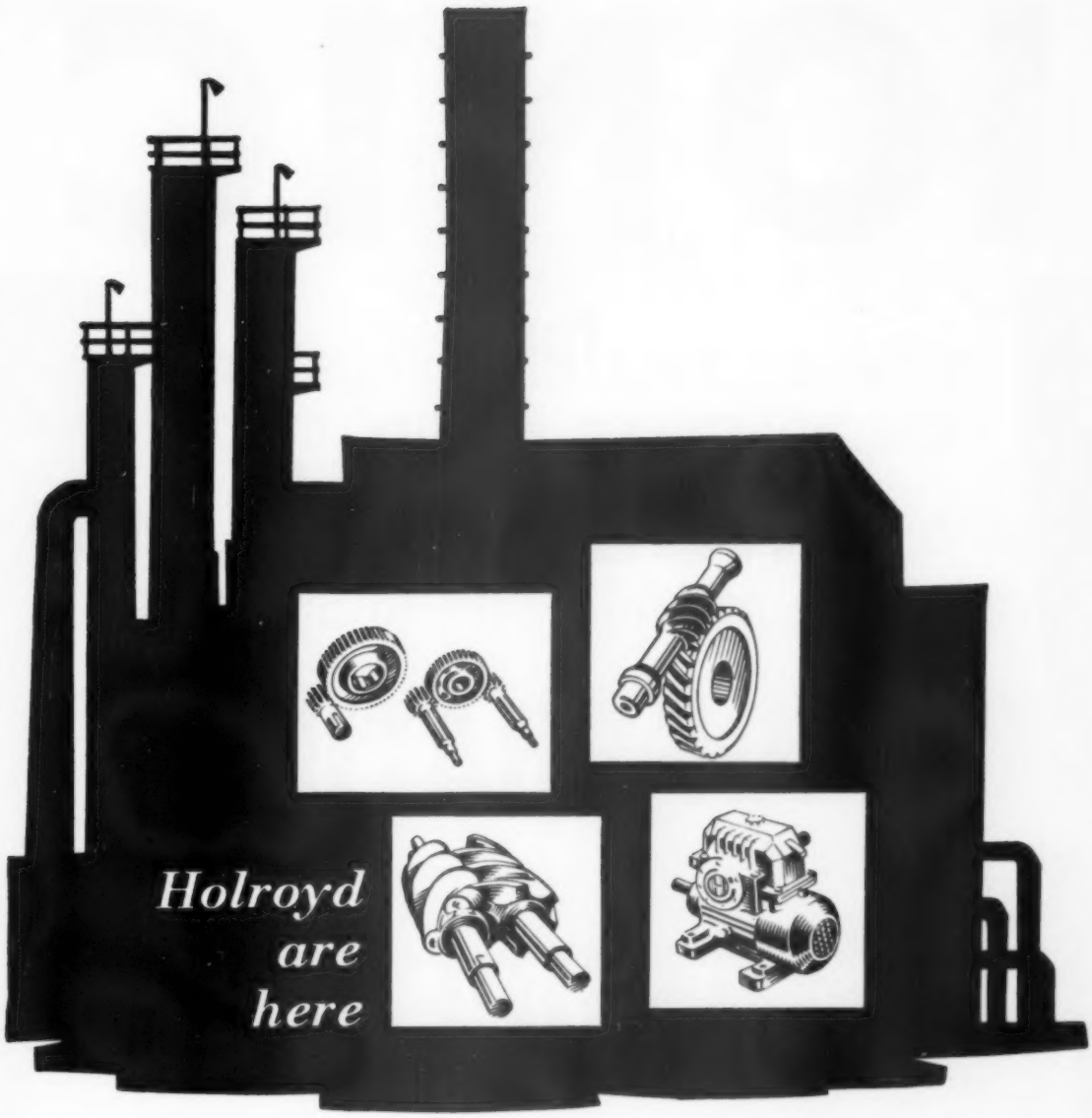

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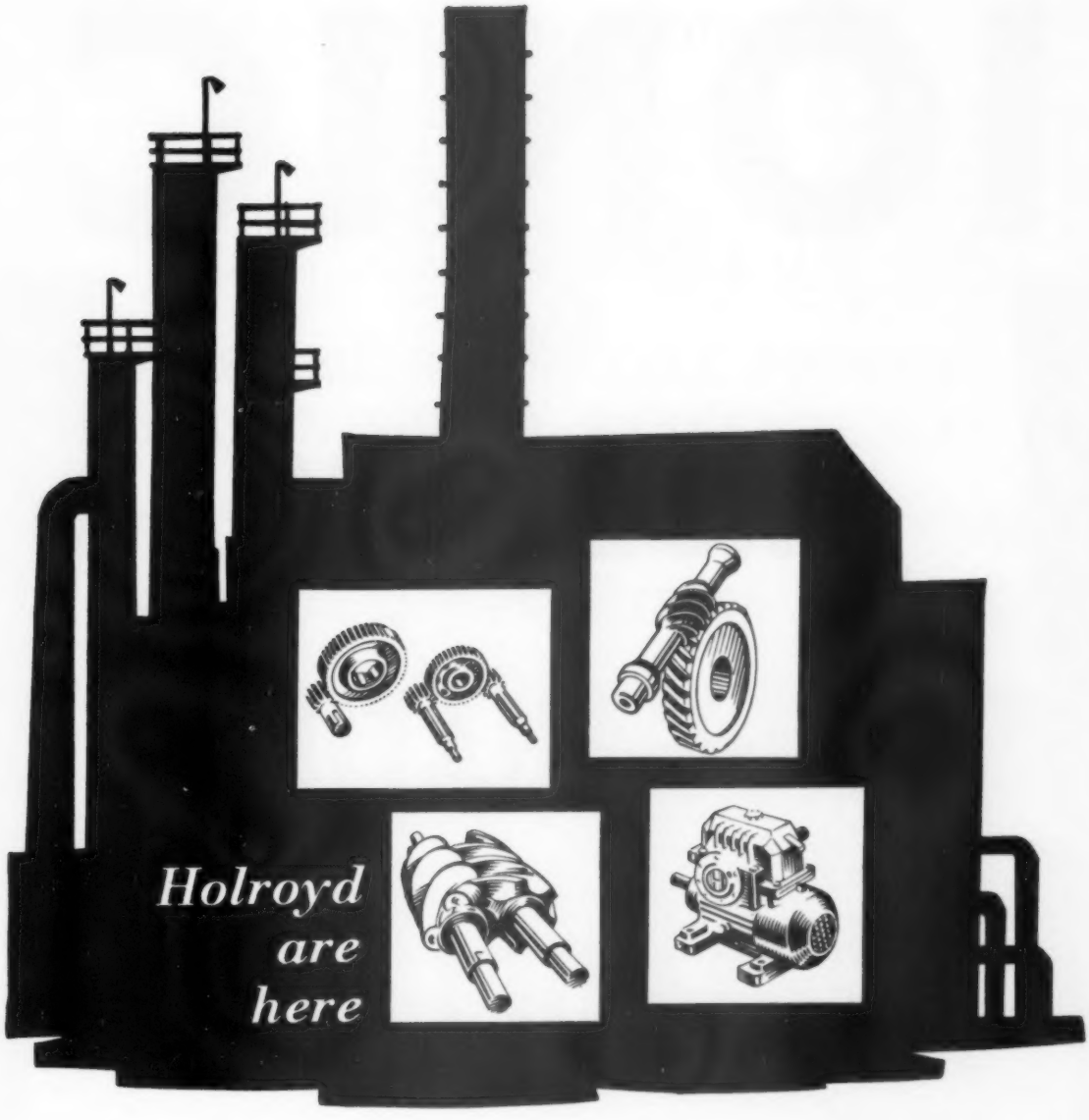

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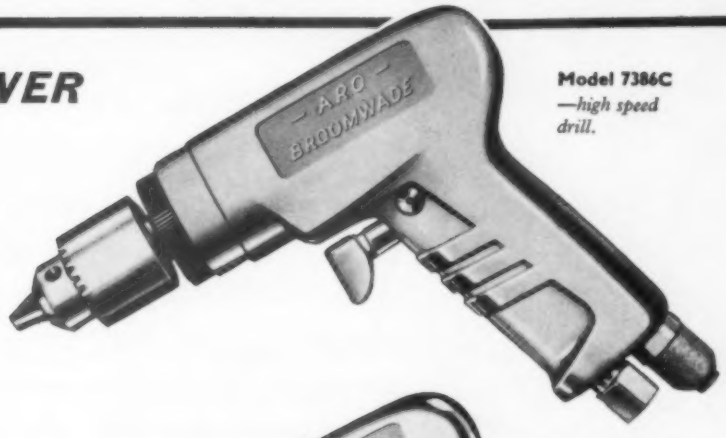

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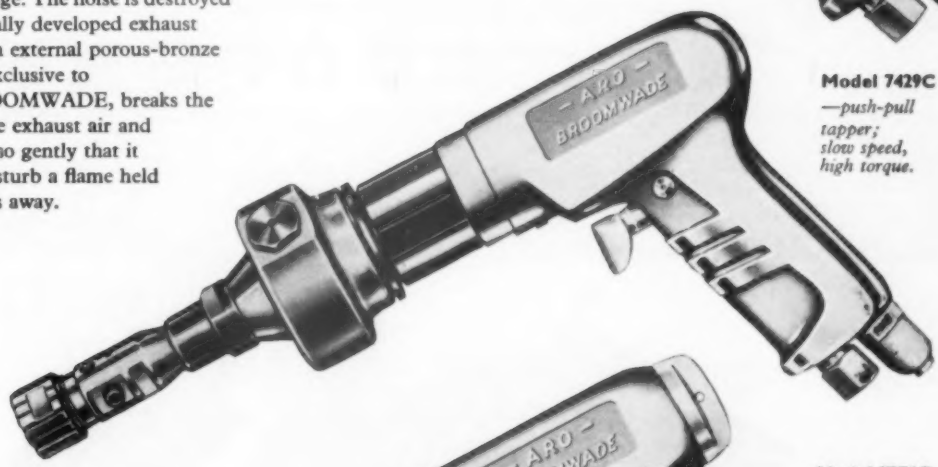

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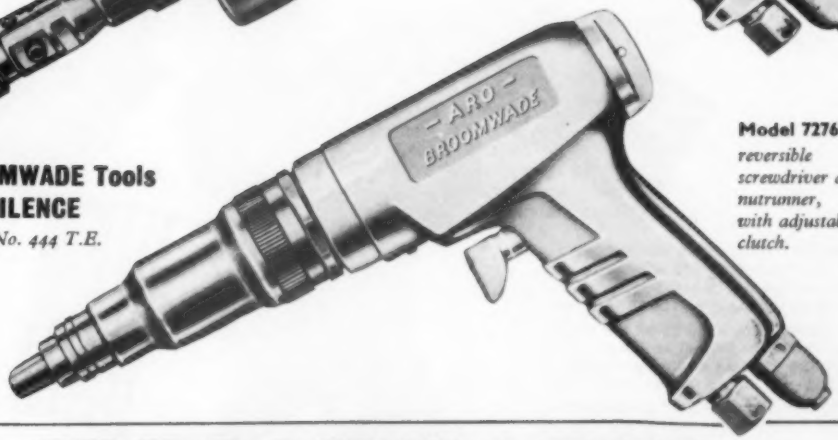

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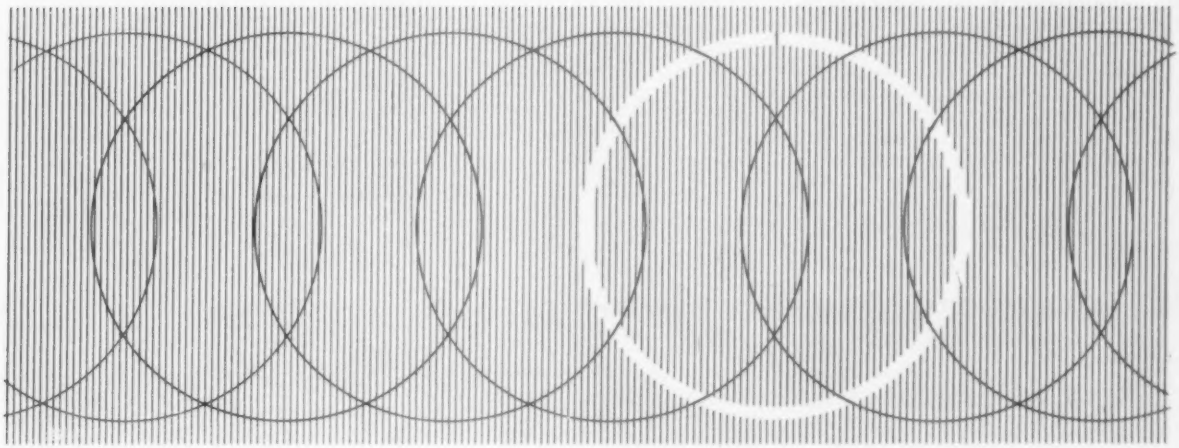

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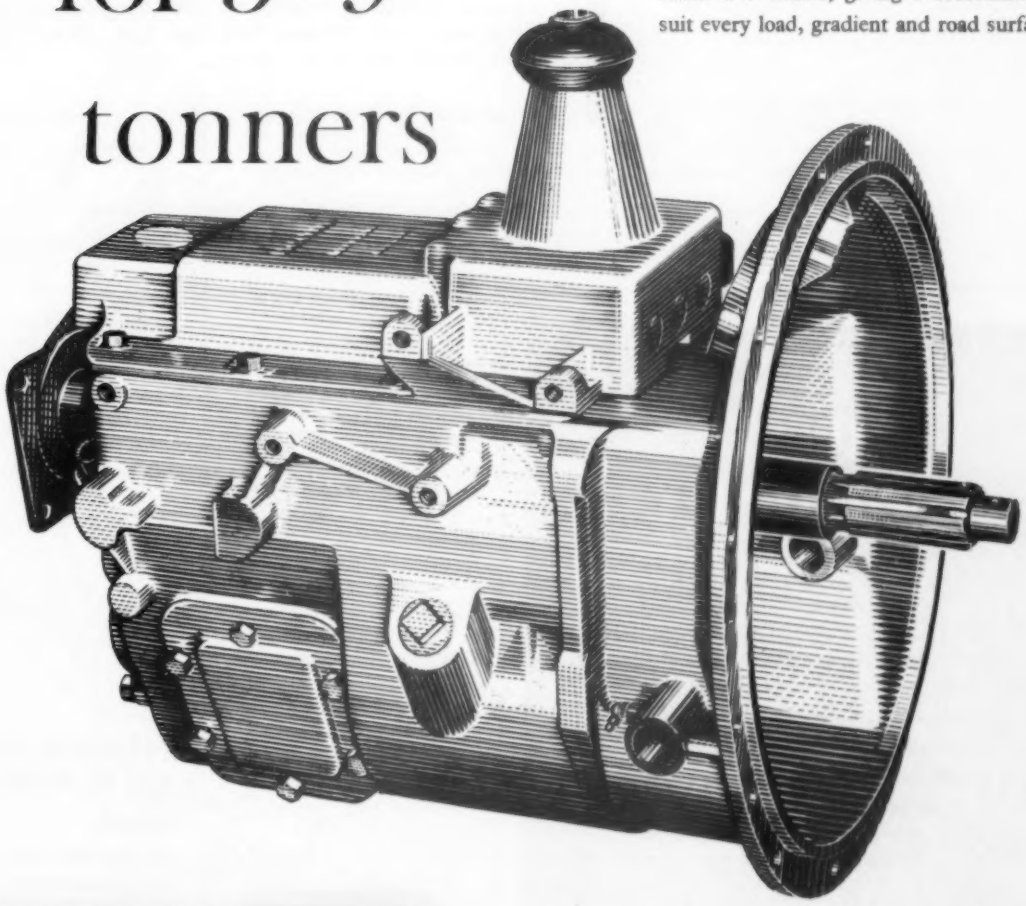

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On the right Mr. W. B. PROSSER, in the centre Mr. J. W. MONTREMY and Mr. W. J. PLATKA Jnr.

Perfect Circle Corporation has just acquired a financial interest (about one-third) in the Société Anonyme Floquet-Monopole, the largest French manufacturer of piston-rings, pistons, valves, and linings. An announcement to this effect has been made by Mr. W. B. Prosser, President of Perfect Circle, and by M. Jean de Montremy, General Manager of Floquet-Monopole, who went to Hagerstown, Indiana, to conclude the agreements.

The Floquet-Monopole company, founded in 1920, has its head office and its chief factories at Poissy on the outskirts of Paris, and has several factories at Marcilly, Liancourt, Rouelles, near Havre. The Company's total staff at the present time is something in the order of 1200 persons.

Floquet-Monopole supplies basic parts to the majority of manufacturers of car and motor-cycle engines, as well as industrial and other engines, operating in France. It is also one of the chief suppliers of spare parts for cars distributed by the commercial network of the French wholesalers and reborers.

Perfect Circle piston-rings are manufactured on licence by Floquet-Monopole on machines designed by Perfect Circle and constructed in Europe.

It is planned to build a new factory at Dreux (a town about 55 miles from Paris). Until the Perfect Circle production line is completely installed in France—this is planned for the beginning of 1962—Floquet-Monopole piston-rings will be manufactured as before.

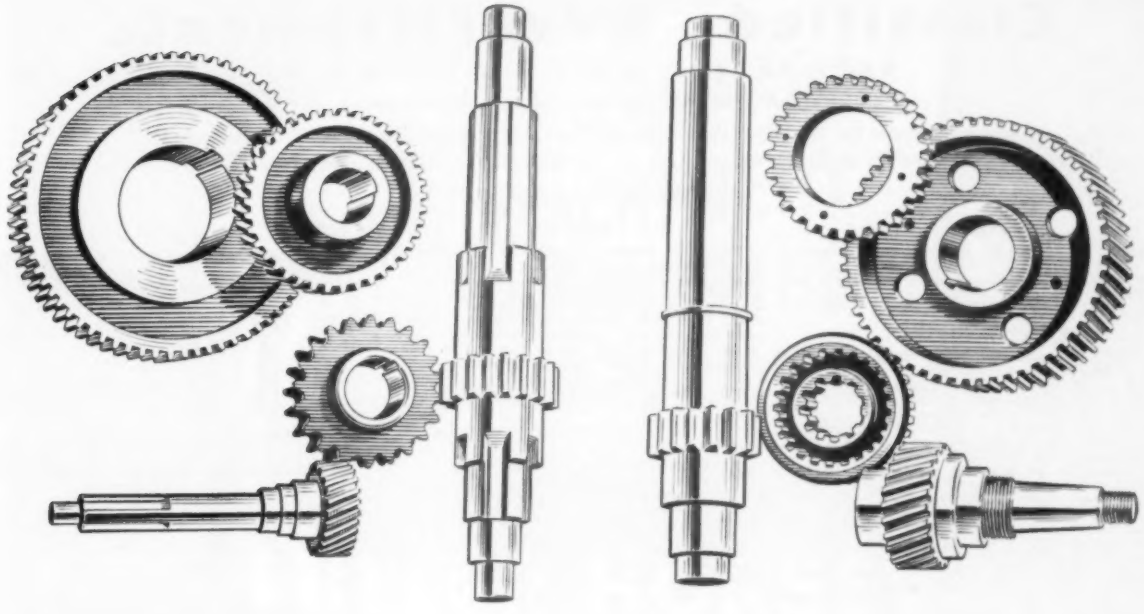
This new association of interests in France increases the commercial possibilities in Europe of Perfect Circle, which already has an excellent market there, both in the domain of spare parts and as supplier of basic parts, notably to Daimler-Benz, Hanomag, I.H.C. (Neuss) in Western Germany; D.A.F. in the Netherlands; Volvo, Scania-Vabis, Atlas Copco in Sweden; and Fiat in Italy.

Already in 1959 a Perfect Circle department was set up at The Hague (Netherlands) to supply the European market which was in process of development.

Other Perfect Circle piston-ring factories exist in Brazil, Argentina, Mexico, Australia, and Canada. With the exception of the one in Canada they have all been founded during the last ten years.

Apart from piston-rings, Perfect Circle manufactures moulded precision parts, speed-control equipment, and electronic planning material.

Thanks to this association of Perfect Circle and Floquet-Monopole, the European Common Market will therefore in its turn have at its disposal production of international class.



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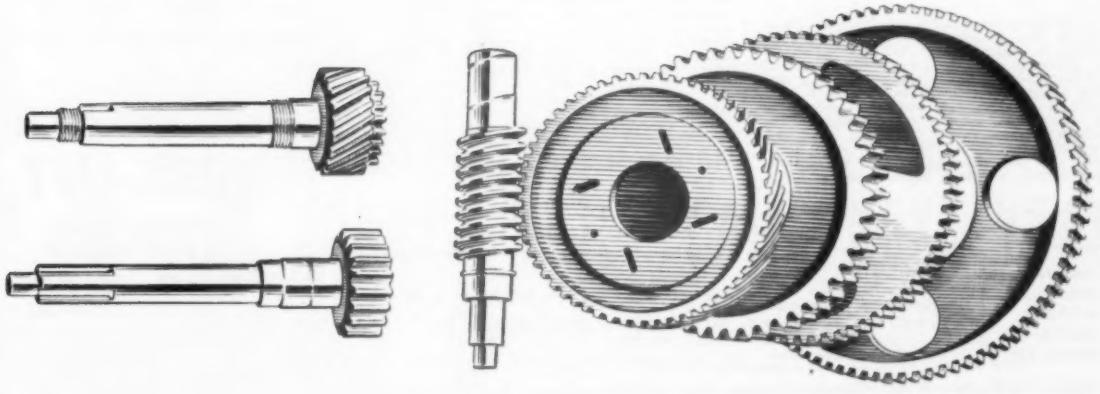

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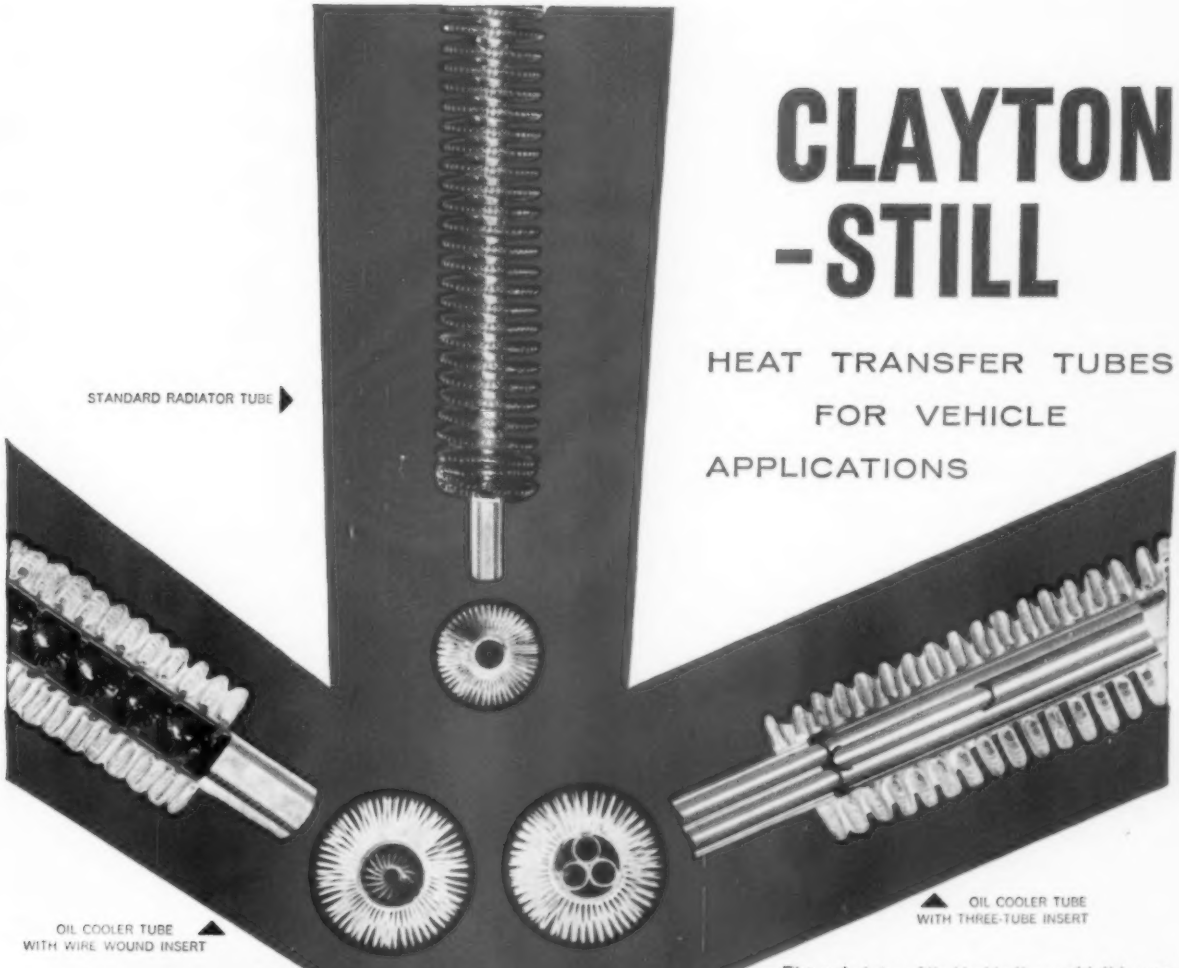

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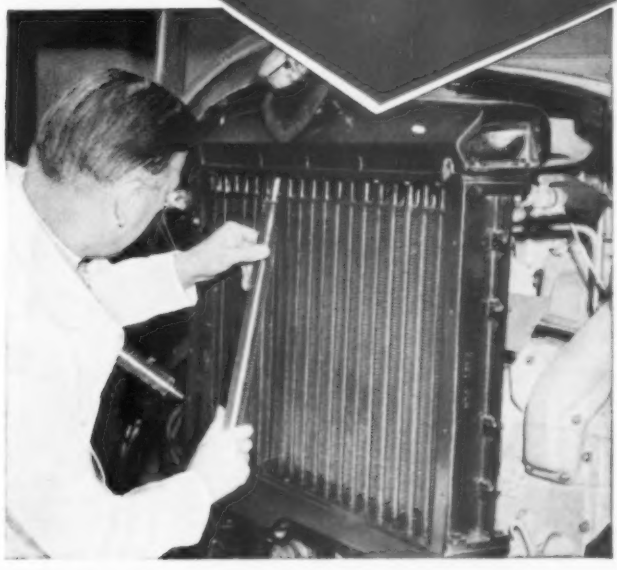

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